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OF THE

Elisha Mitchell Scientific Society

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PROCEEDINGS OF THE TWENTY-SECOND ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE

Held at the North Carolina College for Women, Greensboro, N. C., May 4 and 5, 1923

The Executive Committee of the North Carolina Academy of Science met Thursday night, May 4, 1923, at the North Carolina College for Women, with the following members present: Dr. A. Henderson, Dr. H. B. Arbuckle, Dr. Bert Cunningham, Dr. B. W. Wells, Prof. J. P. Givler, and Prof. H. R. Totten (who acted for Dr. H. N. Gould, who was out of the state).

The committee discussed and adopted the following recommendations to be presented to the Academy:

(a) That the Treasurer be authorized to pay the expense of letters and postage for high school teachers' letters sent out last November.

(b) That the action of President Henderson in appointing Dr. C. W. Stiles to represent the Academy at the Baird Memorial meeting in Washington be confirmed.

(c) That Dr. E. C. Brooks, of the State Department of Education, be invited to speak to the Academy for fifteen minutes on Coöperation of High School and College in Science Teaching.

(d) A fall meeting of the Academy for the especial benefit of high school teachers was discussed, but it was recommended that continued effort be made to organize a Science section in the Teachers Assembly.

(e) That we request each group, viz., the (1) Chemistry, (2) Physics, (3) Mathematics, (4) Biology, Geology, etc., to elect a mem-

ber to represent it upon a committee to study the reorganization of the Academy. In addition to such members the President and Secretary shall be ex-officio members.

(f) After discussion of an amendment concerning the mailing of the ELISHA MITCHELL JOURNAL submitted by C. S. Brimley: that the Secretary-Treasurer be instructed to enforce Section 3, Article 2, of the Constitution.

(g) That dues collected from new members before December 31 shall apply for the JOURNAL year from October 1st preceding; and that dues collected from new members from January 1st to June 1st shall apply for JOURNAL of following year except by special arrangement.

(h) That a committee be appointed to study the problem of publishing a series of nature study pamphlets.*

(i) That the Academy pay to the ELISHA MITCHELL JOURNAL this year the sum of $175.00, rather than $125.00.

(j) That the additional members of the Executive Committee be elected for a period of three years. In the election of the current year, one to be elected for one year, one for two years, and one for three years.

(k) That all bills as presented in the treasurer's report be paid.

(l) That the next meeting be held at Trinity College.

The following names were presented for membership and duly elected:

Alford, Arthur M.
Amick, Harold C.
Amick, Thomas C.
Arnold, Robert B.
Ashe, William W.
Barber, Miss Lena
Bertholf, Lloyd M.
Brannock, N. F.
Brown, E. F.
Bryson, Herman J.
Burke, Miss Blanche
Coker, Robert E.
Coldwell, Miss Inez
Deviney, Ezda
Deyton, John W.
Edwards, C. C.
Fant, Gordon W.
Fritz, R. L.
Goodhue, Miss Elva
Griswold, Miss Sylvia M.
Hartt, Miss Constance E.
Hatley, Charles C.
Heuser, Miss Clara
Highsmith, J. Henry
Hill, M. A.
Hogue, Miss Mary Jane

* This committee was appointed as follows: H. L. Blomquist, Mrs. B. W. Wells, and J. N. Couch.

Ivey, Miss Rachel
Jacka, Miss Estelle R.
Jenkins, Sanford S.
Kuhns, Miss Winifred M.
MacCarthy, Gerald R.
Mackie, E. L.
Markham, Charles B.
McCall, F. E.
Meserve, C. F.
Newlin, R. L.
Pegram, Miss Annie M.
Pickens, Wiley M.
Preston, Robert
Ragsdale, Miss Virginia
Roller, J. H.
Shaeffer, Miss Florence L.
Sherwin, M. E.
Stephenson, I. J.
Strong, Miss Cora
Tucker, Miss Sallie
Walker, Carl H.
Weaver, Robert S.
Wessinger, C. E.
White, Joseph D.
Williams, George A.
Winsor, A. S.
Wolff, Wm. A.
Womack, A. W.
Wood, W. W.
Zoeller, E. V.

The Secretary reported the present membership to be 201, a gain of 38 over last year. Also that 63 were now members of the A. A. A. S., a gain of 50% over last year.

The following were discontinued from membership for the causes indicated:

Members withdrawn: Mrs. E. O. Randolph, V. R. Haber, W. S. Rankin, Dr. C. A. Shore, H. M. Taylor.

Out of state: H. B. Krauz, S. J. Marion, J. K. Plummer, Pattie Groves, Blackwell Markham, J. E. Smith.

Non-payment of dues: R. K. Farrington, Mildred Sherrill, R. Y. Winters.

The report of the Treasurer was read and approved for auditing.

The North Carolina Academy was called to order at 10:30 a. m. Friday morning by President Henderson, and the reading of papers was begun. This was continued until just before one o'clock when the following committees were appointed:

Nominating—H. V. Wilson, J. W. Lake, C. W. Edwards.

Auditing—M. F. Seymour, A. W. Hobbs, R. N. Wilson.

Resolutions—R. W. Leiby, P. O. Schallert, W. L. Porter.

The Academy adjourned to lunch with their hostess at the "Hut."

At 2:00 p. m. the various committees met, and the reading of papers was resumed at 2:30. At 4:30 p. m. the Academy went into business session.

Since the minutes had already been published, they were not read before the Academy, but corrections were called for. As none were made the minutes were approved.

The executive committee reported and the recommendations recorded above were adopted section by section.

The auditing committee reported the financial records to be satisfactory, and the treasurer gave a brief report. The report in more detail is given herewith:

SUMMARIZED FINANCIAL STATEMENT

May 1, 1923

RECEIPTS	
Balance at last audit	$ 135.92
Fees collected	618.00
Total income	$ 753.92
EXPENDITURES	
As per checks attached	$ 597.92
Check balance	156.00
	$ 753.92
RESOURCES	
Check account	$ 156.00
Savings account	314.91
Checks on hand	10.00
Stamps about	.75
Total resources	$ 481.66
LIABILITIES	
Checks outstanding	$ 4.25
Bal. Sec. Comm.	11.50
To balance	465.91
	$ 481.66

Dues uncollected about $40.00.

Fees collected for the Academy	$ 380.00*
Fees collected for A. A. A. S.	248.00
Total collections	$ 628.00*

* This includes the $10.00 of checks on hand.

1922	COMPARISON OF AND	1923
$135.92	checking account	$156.00
203.00	savings account	314.91

Report of the Treasurer approved.

M. F. SEYMOUR,
A. W. HOBBS,
R. N. WILSON,
Auditing Committee.

As predicted the high school committee reported, and their report follows:

Your committee begs to report that it has held two meetings, one in September and one in April, with the entire committee present each time.

At the September meeting it was decided to arrange for a meeting of high school science teachers to be held in Raleigh at the time of the North Carolina Teachers Assembly. Letters were sent to a large number of high school teachers and a program was arranged so as not to conflict with the meeting of the State Physics Teachers Association. The meeting was held as arranged and papers were presented by Messrs. Roller, Wilson, Patterson, and Cunningham.

A considerable number of teachers were present and showed decided interest in the discussions. An account of the meeting was reported in the Raleigh *News and Observer* of December 3, 1922.

Several definite things resulted immediately.

1. An organization was formed with Mr. A. F. Roller of the Raleigh High School as President, and Mr. H. B. Simpson of the Louisburg High School as Secretary.

2. From this organization a request was sent up to the Teachers Assembly for the recognition of a science unit.

3. A dinner party was given at the home of Prof. C. M. Heck, at which definite plans were discussed for putting over a state-wide educational campaign for science in the high school.

4. In February a committee was formed, under the direction of the State Department of Education, for the purpose of visiting and studying a number of high schools. The committee was made up of ten teachers from six different colleges. This visitation was expected to furnish first hand information as to the science courses given, the

nature and amount of equipment, and the quality of the teaching done. It was also understood that the visitors should advise with science teachers, principals, and superintendents as to their particular science teaching problems. Finally by means of talks to students and public lectures the visitors were to try to sell the idea of science to the school and to the community. Most of the information is in the hands of Mr. Highsmith, High School Supervisor, and is being studied by several sub-committees; among them being one on high school science curriculum and one on high school science apparatus and equipment. The large committee has been called to meet today in order to map out further work along this line.

5. Arrangement has been made for the State Department of Education to present the matter of school science to this Academy.

With the foregoing in mind your committee offers the following recommendations:

1. That we favor the formation of a science unit in the N. C. Education Association.

2. That we ask the publisher of the *High School Journal* for a page each month, devoted to science, and that we ask for a chance occasionally to present articles of a scientific interest in the pages of *North Carolina Education.*

3. That we make an effort through the office of the secretary, or through the committee on publicity to get a series of press bulletins out into the weekly newspapers of the state.

4. That we ask the State Department of Education to continue the work of its present committee and if possible to extend its scope and effectiveness.

5. That we establish through the office of the secretary, or through your committee on high school science a Bureau of Information for the benefit of the superintendents, principals, and of science teachers, covering such points as the equipment and courses in the various high schools, the qualifications, experience and effectiveness of science teachers, and the correct placing of these teachers.

6. That this committee be instructed to consider and report at the next annual meeting of the Academy on the advisability of forming a section of high school science in the Academy.

7. That we call the attention of the science departments of the various colleges of the state to the need of courses in the teaching of science, including both the idea of content as well as that of methods;

and that we recommend that such courses be given under direction of the various scientific departments, rather than under the Department of Education.

Respectfully submitted,

BERT CUNNINGHAM,
J. N. COUCH,
A. F. ROLLER,
R. N. WILSON.

This report was adopted and the committee continued.

The publicity committee made the following report:

We recommend:

That a publicity committee of three be appointed.

That the function of the committee shall be three-fold, one member performing one of the functions.

(a) *Publicity through the press.* Especial attention to be paid to the minor, and weekly papers, since the larger papers are already carrying considerable science materials. Materials showing progress of science investigation and practical application as well as startling discoveries should be worked up. This should be made self-supporting.

(b) *Publicity through the platform.* The individual in charge of this should arrange popular lectures on science throughout the state, wiping out entirely institutional lines. By coöperation with the State Department, this group should be self-supporting.

(c) *Publicity through loans.* Lantern slides, microscopic slides, and museum specimens could be loaned to schools. This could be made self-supporting except for the labor, by either of two methods. Either require the schools to pay transportation and breakage, or organize a loan membership which for a definite sum entitles the schools to borrow these things.

BERT CUNNINGHAM,
W. A. WITHERS,
A. H. PATTERSON.

The report was adopted.

It was moved and carried that the executive committee be authorized to carry out the plans outlined above through the agency of a publicity committee appointed by the chair.

The committee consists of (a) R. W. Leiby, (b) B. W. Wells, (c) Bert Cunningham.

The committee on natural resources had no formal report, but Dr. W. C. Coker, a member of the committee, suggested the coöperation of the Academy with the Virginia Academy in securing the conservation of a selected part of the Dismal Swamp.

The Academy went on record as approving this movement. Dr. Coker also reported his visit to the organization meeting of the Virginia Academy of Science. The North Carolina Academy congratulated the Virginians.

The committee on revision and publication of the constitution reported the revision as nearing completion. The committee was continued.

The Nominating Committee reported as follows:

President—C. M. Heck.

Vice-President—J. P. Givler.

Secretary-Treasurer—Bert Cunningham.

Executive Committee—A. Henderson, three years; H. B. Arbuckle, two years; J. W. Nowell, one year.

The secretary was instructed to cast the ballot for the above officers.

President Henderson made a speech about the secretary, who took occasion to absent himself, so no detailed record was made thereof.

The Academy adjourned until 8:00 p. m. At this time the Academy was welcomed to the college by Dr. W. C. Jackson, vice-president of N. C. C. W. Dr. Archibald Henderson responded for the Academy, and then delivered the presidential address, which was a masterly discussion of the "Size of the Universe." A delightful reception was tendered the Academy by the college at the close of the lecture.

The joint session was held at 9:00 a. m. Saturday. At this time Dr. E. C. Brooks of the State Department of Education, at the invitation of the Academy, gave an inspiring talk on Coöperation of Colleges and High Schools in Science Teaching.

The resolutions committee reported as follows:

RESOLVED:

(1) That the North Carolina Academy of Science hereby express its genuine appreciation and delight in the manner in which it has been welcomed and entertained by the North Carolina College for Women.

(2) That the Academy express its appreciation of the very great contribution made by the State Department of Education to the advancement of the teaching of science in North Carolina and that it pledges its hearty and continued support to this program in every way possible.

(3) That the Academy express its thanks to the various college administrations which have contributed to the campaign in men and equipment and that we ask for a continuance of such support on the part of all the colleges of the state.

(4) That the Academy hereby recognize the effort of its officers in making this meeting the success that it has been; and we would especially recognize the efficient and wholehearted services of our secretary, and hereby express our appreciation of his labors.

(5) That the Academy most strongly urge the preparation by the authors of abstracts of papers given before the Academy that are not to be published in full, these to be furnished the secretary immediately after the presentation of the paper.

The report was adopted.

The Academy then went into separate meetings—viz.:

North Carolina Section of American Chemical Society.

North Carolina Physics Teachers Association.

Mathematics Section.

Biologists, etc.

Miss Elizabeth Kelly, president of the State Teachers Assembly, was introduced to the Academy and spoke a few minutes.

The following were elected to serve on the reorganization committee:

Biological-Geological section—W. C. Coker.

Chemical section—P. M. Gross.

Mathematical section—K. B. Patterson.

Physical section—C. W. Edwards.

The North Carolina Physics Teachers Association meeting with the Academy elected officers as follows:

President—W. T. Wright, N. C. C. W.

Vice-President—A. A. Dixon, State College.

Secretary-Treasurer—A. L. Hook, Elon College.

The North Carolina section of the American Chemical Society meeting at the same time and place elected the following officers:

President—J. O. Halverson, Department of Agriculture.

Vice-President—F. C. Vilbrandt, Department of Chemistry, University.

Secretary-Treasurer—L. B. Rhodes, Department of Agriculture.

The Mathematics Section elected as president, J. W. Lasley, Jr.

The presidential address by Dr. Henderson is to appear in *Science.*

Among the papers presented to the Academy the following appear in full in this issue of the JOURNAL:

Dedifferentiation in Hydroids and Ascidians. H. V. Wilson.

Soil Treatments to Overcome the Injurious Effects of Toxic Materials in Eastern North Carolina Swamp Land. M. E. Sherwin.

Contractile Vacuoles in Amoebae. Mary Jane Hogue.

Variation of Protein Content of Corn. Paper II. H. B. Arbuckle and O. J. Thies, Jr.

Density of the Cell Sap of Plants in Relation to Environmental Conditions. C. F. Korstian.

The Research Program of the Appalachian Forest Experiment Station. E. H. Frothingham.

The Breeding Habits of Limnoria at Beaufort, N. C. R. E. Coker.

Chemical Industries in North Carolina in 1922. Frank C. Vilbrandt.

The Common Names of Some Trees. W. W. Ashe.

Some Points in the Bud Development of a Simple Ascidian, Ecteinascidia turbinata Herdman. C. Dale Beers.

Of other papers presented the following abstracts have been received:

The Pure Culture of Diatoms. BERT CUNNINGHAM.

Previous reports* have been made to the Academy upon methods

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* Cunningham, B. Pure Culture Method for Diatoms. This Journal **36**: 123. 1921.

for the pure culture of diatoms. It was pointed out that the bacteriological method as well as other previous methods were unsatisfactory since one could not be absolutely certain that cultures were pure due to the fact that diatoms are able to migrate over agar even when it is quite solid. It seemed advisable therefore to start cultures from a single individual, segregated by a modified Barber's pipette which has been previously described.* This was done in May last year. Transplants were made from these cultures and some fifty tubes have been secured, containing thousands of diatoms each. This technique should make possible an absolutely accurate method for the study of variation in the marking of the shells of diatoms, and may possibly show that some species are to be looked upon as variants rather than as distinct species. It is perhaps needless to say that this work should be carried on with bacteriological accuracy, and that the nutrient agar should be filtered before using since agar usually contains diatom shells. This method also makes possible a study of the physiology of the diatoms.

Some of the Hepaticae of North Carolina. H. L. BLOMQUIST.

A report on a survey of the liverwort flora of the western half of the state extending over a period of less than one year. Out of the ninety-six genera occurring in the United States, Canada, and Alaska, thirty-seven were located in this region of North Carolina during that time. The largest number of genera collected belong to the order Jungermanniales, or leafy liverworts. The Marchantiales are not so well represented and are rather local in distribution. In the Ricciaceae family, *Riccia sorocarpa* Bisch seems to be the most widely distributed, occurring during the winter months in clay fields together with *Sphaerocarpus texanus* Aust. The most common of the *Marchantiaceae* in the Piedmont region is *Asterella tenella* which occurs on low clay fields together with *Anthoceros laevis.* The rarest leafy liverwort located is *Metzgeria furcata* var. *ulvula.* This was collected on Eno River near Durham and identified by Miss Lorenz who says that in her extensive collecting she has obtained it only once. Below is a list of the genera reported:

* Cunningham, B. A Modified Barber Pipette. Trans. Amer. Mic. Soc. **41**: 55.

Marchantiales
- Riccia
- Reboulia
- Asterella
- Lunularia
- Conocephalus
- Marchantia

Jungermanniales Anacrogynae
- Sphaerocarpus
- Riccardia
- Metzgeria
- Pallavicinia
- Pellia
- Fossombronia

Jungermanniales Acrogynae
- Nardia
- Jamesoniella
- Plagiochila
- Lophocoleia
- Cepholozia
- Chiloscyphus
- Harpanthus
- Marsupella
- Lejeunia
- Jungermannia
- Odontoschisma
- Calypogeia
- Kantia
- Bazzania
- Lepidozia
- Trichocolea
- Diplophyllum
- Scapania
- Radula
- Porella
- Cololejeunia
- Frullania

Anthocerotales
- Anthoceros
- Notothylas

Aspects of Constant Curvature. ARCHIBALD HENDERSON.

In this paper, Dr. Henderson outlined a number of ways for determining the value of the Gaussian curvation on surfaces of constant curvature. This was shown to be intimately associated with the expression for the linear element on the surface. Making use of two forms given by Riemann for the linear element of a surface of constant curvature, it was shown by appropriate examples how the curvature could be singled out by inspection. Illustrations were given for the sphere, written in three different ways, parametrically, and for the pseudo-sphere as compared with the sphere of imaginary radius. Attention was called to the fact that little had been done in this direction; and that there was room for the display of great ingenuity in devising parametric representation of surfaces suitable for the purpose of determining curvature.

Physical Factors in the Artificial Incubation of Eggs. CHARLES M. HECK.

A review of the research that has been done on the incubation of eggs shows that temperature control, humidity regulation, and ventilation are involved in the following manner. Temperature control is more important the longer the incubating temperature has been maintained, and commercial devices fully meet the demands of this con-

trol. Humidity is important throughout the whole of the incubating period and, if not supplied in sufficient amounts when the ventilation requirement is high, the chick will not grow in size or strength enough to free himself from the tough membrane surrounding him or from the shell. If too much moisture be supplied the reverse will occur; namely, the chick will grow too large to perform the necessary revolution in the shell and the liquids and membrane surrounding him will not have dried enough before the shell is punctured to prevent strangulation or gumming up of the bill of the chick in its effort to get out.

The control of ventilation necessary for the best hatching has been studied from data gained by analysis of the carbon-dioxide found under sitting hens. The curve plotted from the amount of CO_2 per ten thousand parts of air taken each day throughout the period of incubation shows a rapid ascent beginning about the tenth day and amounting to 60 parts in ten thousand at the end of the hatch. The author undertook to devise automatic means for supplying ventilation in an amount proportional to the amount of CO_2 found at any time.

The method of doing this was suggested by the fact that the curve mentioned had been found to be parallel to the curve for the weight of the embryo and also the amount of animal heat generated. On the basis of this proportionality of animal heat, the principle of action devised was to have the heat supplied to a horizontal surface above the eggs when heat only was desired, but, when heat and ventilation were desired, have the heat supplied to a vertical flue somewhat longer than the depth of the incubator. All that is necessary to control the amount of ventilation with this arrangement is to adjust at the beginning the amount of heat supplied by a rheostat, if electrically operated, or turn up the lamp, if by combustion, so that the amount of heat supplied when the horizontal element is operating is sufficient or slightly too great without the addition of animal heat. As the amount of heat supplied when the vertical heat element is operating is made slightly too small even when the animal heat is at a maximum, the switching of the heat from one element to the other by a thermostat placed just above the eggs gives the required heat control.

The practical construction of such devices is very simple and their operation very successful. In practice it will be found that the thermostat will operate in the following manner: At the beginning when adjusted the heat will be supplied some nine-tenths of the time

to the horizontal heating unit placed above the eggs and one-tenth of the time to the ventilating unit in the flue. After the third day slightly less of the time will the heating unit above be running and correspondingly more of the time will there be ventilation supplied by the heat remaining longer in the flues. This change of ratio continues until near the end of the hatch it has been reversed, and ventilation is being supplied nine-tenths of the time as against heat alone, without ventilation, one-tenth of the time.

Comparison with the rate of ventilation supplied by commercial types of incubators for eggs showed that all of them operated in the reverse of this. The ventilation is associated with the heat in such a manner that the more heat supplied the more ventilation. But the amount of heat supplied is greater when no animal heat is being generated. Consequently, to get enough ventilation at the end of a hatch when the heat requirement is least, there must be an excessive supply of ventilation associated with the flow of heat throughout the whole period. The author feels that this excessive ventilation throughout the hatch and the consequent drying out of the eggs is the principal cause of the low efficiency of commercial incubators of today. Not only is the per cent of the hatches much below that obtained from hens, but the weight of the chicks hatched is about twenty per cent lower.

Savannah and Sand Ridge Plant Communities. B. W. WELLS.

The habitat of the savannah community is a level non-draining area with the water table at or very close to the surface. The community is dominated by the grass *Campulosus aromaticus* and species of *Sarracenia,* especially *S. flava.* A majority of the species show tendencies toward xerophytism. A large number are characterized by radical leaves whose whitened bases join the stem 1-3 inches below the surface. This character doubtless has a significance in relation to fire.

The habitat of the sand ridge community is a more or less rolling area, the soil being composed of coarse sand which except at the surface is very dark, due to humus. So clean does the rain wash the upper ½ inch of sand that it assumes a brilliant white aspect. The reflection of the heat and light from this creates extreme conditions of temperature near the surface. This community is typically domi-

nated by *Quercus Catesbaei* (Turkey Oak) and *Aristida stricta.* Both of these together with a number of other plants show striking adaptations to this unusual habitat.

The above two habitats and their respective communities are found in the coastal plain and are sufficiently distinctive to give them a place among the major plant associations of the state of North Carolina.

A New Vacuum Gage. MARSTON LOVELL HAMLIN.

A vacuum gage is described, the basic principle of which is the same as that of the McLeod and Gross gages, but in which the compression of the residual air in the gage to a definite volume is brought about without the use of a mercury leveling bulb or plunger. The gage is rotated about a fixed axis and the small amount of mercury in the gage is thereby poured down a tube, trapping a definite volume of air. The inclination of the gage is adjusted so that the head of mercury on the imprisoned air is sufficient to compress it to a predetermined volume, and the pressure corresponding to that inclination is read off on a segment of a circle graduated to read directly in millimeters of mercury.

The gage may be constructed with two or more working ranges, as for example, Range 1, 0.1-15.0 mm; Range 2, 0.01-1.500 mm, etc.

Recent Improvements in Amoeba Culture Methods. LLOYD M. BERTHOLF.

The author, after pointing out the non-dependibility of the methods of culturing amoebae ordinarily employed, gives a method worked out by J. G. Edwards at Hopkins and somewhat modified by his own experiment. A hay infusion is made of timothy hay and spring water; this is allowed to stand until it clears; it is then inoculated with *Amoeba proteus*; and in a few weeks the amoebae appear abundantly, feeding on the flagellate protozoon *Chilomonas.* The author gives a few hints as to how to mix the infusion and how to keep it going for several months, and by transferring occasionally, for years. A discussion is given of the reasons why the timothy hay cultures produce such good results in rearing amoebae.

Some Phases of Digestion in Cambarus. WILLIAM A. WOLFF.

I. Carbohydrates. *Cambarus* takes and digests carbohydrate food.. Enzyme extract from both intestinal and liver tissue digested starch and maltose, sucrose in some instances, but not lactose. Amylase and maltase were found in the intestine; sucrase and lactase were absent. In the liver amylase, maltase, and traces of sucrase were found, but lactase was absent.

Twinning and Polyembryony in Insects. R. W. LEIBY.

In the polyembryonic development of some of the parasitic insects as many as 160 to 2500 individuals are developed from a single egg deposited by the parent parasite in the egg of the host. The development of the parasites is completed in the larval stage of the host.

In the case of *Platygaster hiemalis,* a parasite of the Hessian Fly, a group of four to eight eggs is deposited in the egg of the fly. Some of the eggs of the group develop monembryonically, while other eggs of the same group develop twins. The cleavage nucleus divides once while located in a differentiated embryonic region of the egg. The two daughter nuclei then divide to form four embryonic nuclei. In the case of an egg that is destined to produce twins, the embryonic region of the egg divides at this stage, two of the embryonic nuclei passing to one embryonic region and the other two nuclei to the second embryonic region. Each embryonic region with its component embryonic nuclei and paranuclear masses finally develops into a parasite larva, and then into an adult parasite. The process of development of twins is identical with that of a single individual, except that in the former instance the embryonic region divides at the 4-cell stage, while in the latter instance it fails to divide at the 4-cell stage. Approximately eight parasites develop in a single host larva.

The twinning development of this insect is the first specialized step from monembryony to polyembryony.

The Relation of Diet to the Development and Preservation of the Teeth. F. W. SHERWOOD.

A review with especial emphasis on the work of McCollum and of Howe.

The former has shown that when rats are fed diets which contain a faulty calcium: phosphorus: organic factor ratio marked dental defects result.

Howe and others have shown that scorbutic diets also have marked deleterious effects on the teeth and associated tissues.

Both of these investigators call attention to the similarity between these artificially produced dental defects and caries and pyorrhea in man.

The necessity of applying the newer knowledge of nutrition for the prevention of dental caries was pointed out. This is especially important in the early years of the child.

The Copperhead Snake at Raleigh, N. C. C. S. BRIMLEY.

Not uncommon, 61 specimens being on record from 1885 to 1922; four human beings and one dog have been known to be bitten by it, all of whom recovered; both in nature and in capitivity seems to be a comparatively good tempered snake. Short notes on diet and reproduction.

Will be published in full in Copeia.

A Simple Microphotographic Apparatus. J. B. BULLITT.

Good photomicrographs may be made with a simple home-made apparatus. An ordinary microscope, with its tube tilted to the horizontal position, is set at about the middle of a thirty-inch plank. At each end of the plank a plain wooden box is placed. On the proximal surfaces of the boxes a hole is bored in each, in alignment with the microscope tube. One end of a cloth sleeve is tacked to the face of box No. 1, encircling the hole. The other end covers the microscope ocular. A draw string makes this a light proof connection. The microscope mirror is removed and secured upon a small stand in box No. 2, where its concave surface reflects the light from an incandescent lamp through the hole in the wall of this box and into the Abbe condenser. This projects the image of the microscopical preparation upon a screen at the back of box No. 1. The image is seen through a window in the top of the box. The screen is made by pasting a piece of white paper upon an old photographic plate and inserting this in the usual plate holder. The plate holder fits snugly through a slot cut in the back part of the top of the box. After focusing the projected image, the light is cut off, a small piece of board is laid over the window in the box top and a photographic plate is substituted for the screen. The exposure is now made by turning on the light. The whole apparatus can be made at a cost of less than five dollars. It is not

bulky, is easily manipulated and, in the hands of a novice, yields better results than he can usually obtain with a regular photomicrographic camera.

Rainfall Characteristics of North Carolina. THORNDIKE SAVILLE and R. J. MORTON.

A map of North Carolina has been prepared showing isohyetal lines (lines of equal annual rainfall), compiled from station averages to 1921. The last such map appeared in 1890. A map of the state has also been prepared showing lines of equal coefficients of variation from the mean annual rainfall. Curves of progressive means of annual rainfall for selected stations in the state have been prepared to investigate periodic changes in rainfall. No definite rainfall cycle has been indicated at any station. At Hatteras a distinct climatic change seems indicated, involving a decrease in annual rainfall. It is believed that progressive means may be used to prognosticate the probable trend in rainfall for a year or two in advance. The studies reported upon are being continued and will be published.

McCrudden's Volumetric Method Compared With the Shohl and Pedley Method for Determination of Calcium. J. O. HALVERSON and L. M. NIXON.

1. McCrudden's method as modified by Halverson and Schulz (Jr. Ind. & Eng. Chem. **12**: 77. 1920) gives accurate results in the determination of Ca in urine if the urine is oxidized with ammonium persulphate before proceeding with analysis.

2. Results obtained by this method average 4.5 per cent more accurate and are more uniform than those obtained by Shohl and Pedley's method. (Jr. Biol. Chem. **50**: 537. 1922). This is important where only small amounts of Ca are present, as in agricultural and biological products.

3. There is little difference in the time necessary for carrying out the two methods.

On the Curvature of Manifolds. J. W. LASLEY, JR.

A surface may be regarded as a two-parameter family of points. Its linear element is then given by a quadratic differential form in two variables. We regard surfaces thus characterized as manifolds

of two dimensions. Extending these notions to higher dimensions we consider quadratic differential forms in any number of variables as characterizing manifolds of the same number of dimensions.

The problem of measuring the curvature of surfaces, or manifolds of two dimensions, is a problem well known to mathematicians. The corresponding problem of obtaining a satisfactory measure for the manifolds of higher dimensions has received much less attention, and what has been done upon the problem is not readily accessible.

For the case of four variables the matter is of vital importance to mathematicians and scientists generally who desire to comprehend the hypotheses advanced by Professor Einstein as regards the nature of the universe in which we live.

The present paper sets out to study some of the means that have been suggested for measuring the curvature of manifolds. It mentions the measures of curvature of Gauss, of Sophie Germain, and of Casorati for the case of two variables. Presupposing that the classical account of Gaussian curvature is familiar because it is so readily accessible, the presentation of Gaussian curvature is that of an absolute invariant of a quadratic differential form under a functional transformation. The details of this consideration lead to algebraic quadratic forms, Christoffel symbols and tensors of rank two and four.

For manifolds in any number of variables the measures of curvature suggested by Riemann and Einstein are developed in detail and their relation to each other and to the curvature of Gauss pointed out. A number of examples of the various measures of curvature are given.

Secondary Electron Emission from Tungsten and Iron. OTTO STUHLMAN, JR.

It was found that when thermions liberated from a tungsten filament were accelerated and allowed to impinge on a metal grid maintained at a variable positive potential that secondary electrons were emitted from the grid. The number of such secondary electrons emitted was measured by means of a galvanometer in series with the grid and a plate maintained at a constant positive saturation potential.

On plotting the secondary current as a function of the accelerating voltage acting on the primary electrons, a sudden change in the slope of the curves occurring at critical potentials was interpreted in the usual way. The energy-quantum relation V (volts) L (Å) = 12320 was used to compute the equivalent wave-lengths.

The following table gives the preliminary results thus far discovered. The quantities bracketed are still doubtful. Those preceded by an (a) are not found by the usual breaks in the curves but are positions on the continuous curves where the ratio of the number of secondary (s) electrons per primary (p) were such as indicated in the s/p column. At present it appears as if the convergence wave-length (s/p = 3) for tungsten ended at 91.2 Å and is followed by an absorption band extending probably down to 14 Å. This is then followed by the $M\alpha$ line here extrapolated from the above measurements.

TUNGSTEN

Volts	Wave-length (Å)	S/P	Remarks
4.4	2800		Hull found 2700 shortest spark spectrum
(17)	(725)		Suspected
35.0	352		
(60)	(205)		Doubtful
135	91.2	3	
144	a85.6	2.5	
181	a68.0	2.0	
295	a41.7	1.5	
435	a28.3	1.0	From X-Ray
( )	( )	0.0	Extrapolated
1750	7.04		$M\alpha = 7.007$

IRON

Volts	Wave-length	Remarks
3.3	3763	
8.5	1450	Millikan's iron spectrum shows 1430 and 1409
10.4	1184.6	also 1184
24.3	507.0	also 506 and 552.1 Intensity 7 $M\alpha$ computed from Sanford's formula gave 484 Å
45.8	269	Iron shows spectrum 271.6 Å
( )	a( )	Doubtful
200	a 61.6	

The following papers were presented but for various reasons abstracts have not been furnished:

The Importance of Calcium in Relation to Rickets. J. O. HALVERSON. (By title.)

Fossil Remains of an Ancient Mammal in East Central Texas. E. O. RANDOLPH. (By title.)

The Present Condition as to Ether Theories. A. H. PATTERSON. (By title.)

Some Methods in Anatomical Technic. W. C. GEORGE. (By title.)

Strawberry Leaf Scorch. F. A. WOLF.

Hydrogen-ion Concentration in Certain Trout and Sunfish Waters of Western North Carolina. R. E. COKER. (By title.)

Technique of the Mimeograph-mimeo-scope Method of Publishing Temporary Illustrated Science Text-books and Laboratory Guides for Schools and Colleges. J. P. GIVLER.

The Generic Significance of the Genitalia of Insects. Z. P. METCALF. (By title.)

Some Observations on the Righting Reaction in Starfish. B. NOYES.

Effect of Fertilizers on Germination and Seedling Growth of Corn and Cotton. M. E. SHERWIN. (By title.)

A Discussion of the Loss of Mass in the Formation of Helium from Hydrogen. J. B. DERIEUX.

Tests of Results in Physics Teaching. C. W. EDWARDS.

Drop of Potential in Transformer Oil. N. B. FOSTER.

What Happens at Absolute Zero? A. H. PATTERSON.

An Electrolytic Interrupter. A. A. DIXON.

A Standard for the Solution of Problems. J. B. DERIEUX.

A Review of the Work on Isotopes. A. A. DIXON.

The Formation of Layers in Inorganic Solutions. F. W. COOKE.

The Chlorination of Juglone in Hot Acetic Acid. A. S. WHEELER and J. L. McEWEN.

The Bromination of 2-Amino-p-xylene. A. S. WHEELER and E. W. CONSTABLE.

A New Ketone Reagent: p-Bromophenylsemicarbazide. A. S. WHEELER and J. A. RENDER.

The Constitution of the Dichlorohydroxyethylidene-bisnitroanilines. A. S. WHEELER and S. C. SMITH.

Problems of the Chemist in the Textile Industry. K. W. FRANKE.

A Peculiar Reaction Between Dichloroacetic Acid and Aromatic Amines. A. S. WHEELER and S. C. SMITH.

A Suggestion in Regard to Some Problems Relating to the Hydration of Ions. E. E. RANDOLPH.

A Peculiar Phenomenon of a Bunsen Burner. H. B. ARBUCKLE.

The Formation of Rat Spermatozoa Agglutinins in the Rabbit, with a Brief Discussion of the Problems of Tissue Immunity. (Presented by Chas. Phillips.) W. E. TAYLOR and H. N. GOULD.

Some Biological Aspects of the Cancer Problem. CHAS. PHILLIPS.

Oogenesis in Some Species of the Saprolegnias. J. N. COUCH.

A New Species of Thraustotheca and a Related Achlya. W. C. COKER. (The new species appears in full in this issue).

Economic Status of the Forests of the Southeastern United States. W. W. ASHE. (By title.)

The Age and Structure of the North Carolina Newark. COLLIER COBB. (By title.)

Transportation Problems in Relation to Our Changing Environment. COLLIER COBB. (By title.)

The complete list of members follows, those in attendance at the meeting being starred.

Alford, A. M., Farm Life Academy.......................................Star
Amick, H. C., Teaching Fellow in Geology, Univ. N. C..............Chapel Hill

Amick, T. C., Ph.D., Prof. Mathematics, Elon College............Elon College
Andrews, W. J., Civil Engineer....................................Raleigh
*Arbuckle, H. B., Ph.D., Prof. Chemistry, Davidson College....Davidson College
*Arnold, R. B., Chemical Engineer, Hall Tob. Chem. Co................Durham
Ashe, W. W., Asst. Dist. Forester........................Washington, D. C.
Bahnson, F. F...Winston-Salem
*Baker, Miss Lucretia, Meredith College.............................Raleigh
Balderson, Mark, 541 W. 123 St...........................New York, N. Y
*Barber, Miss Lena, M.S., Prof. Biol., Meredith College...............Raleigh
*Barnes, J. T...Roanoke Rapids
Barrett, H. P., M.D., 211 Vail Ave..............................Charlotte
Barrow, Miss Elva E., 5817 Kenwood Ave.......................Chicago, Ill.
*Bell, J. M., Ph.D., Prof. Chemistry, Univ. N. C...................Chapel Hill
*Bertholf, Lloyd M., Dept. Biol., N. C. College for Women...........Greensboro
Binford, Raymond, Ph.D., Pres. Guilford College.............Guilford College
*Blomquist, H. L., Ph.D., Asst. Prof. Biology, Trinity College.........Durham
Bonney, Miss E. C...Hickory
Bottum, Miss F. R., Teacher of Biology, St. Mary's School...........Raleigh
*Brannock, N. F., Dept. Chemistry, Elon College..................Elon College
Brimley, C. S., Asst. Entomologist, 515 Washington St...............Raleigh
Brimley, H. H., Curator N. C. State Museum..........................Raleigh
Brown, W. H., Prof. Elec. Eng., State College.......................Raleigh
*Brown, E. F., Dept. Mathematics, Univ. N. C....................Chapel Hill
Bruner, S C., Chief Dept. Vegetable Pathology and Entomology
Estacion Agronomica........................Santiago de las Vegas, Cuba
Bryson, H. J., Asst. in Geology, Univ. N. C......................Chapel Hill
*Bullitt, J. B., M.D., Prof. Pathology, Univ. N. C.................Chapel Hill
*Burche, Wayne, Asst. Prof. Physics, Trinity College..................Durham
Burke, Miss Blanche, New Bern High School, 101 Pollock St.........New Bern
Cain, Wm. K., LL.D., Prof. Emeritus of Mathematics, Univ. N. C....Chapel Hill
*Campbell, Miss Eva G., Inst. Biol., N. C. College for Women........Greensboro
Clapp, S. C., Supt. Mtn. Exp. Station..........................Swannanoa
Cobb, Collier, Sc.D., Prof. Geology, Univ. N. C....................Chapel Hill
Cobb, Wm. B., Assoc. Prof. Agronomy, Univ. Louisiana.......Baton Rouge, La.
Coker, R. E., Ph.D., Prof. Zoology, Univ. N. C....................Chapel Hill
*Coker, W. C., Ph.D., Prof. Botany, Univ. N. C....................Chapel Hill
*Coldwell, Miss Inez, Asst. Prof. Biol., N. C. College for Women.....Greensboro
Collett, R. W...White Hall, S. C.
*Couch, J. N., Inst. Botany, Univ. N. C..........................Chapel Hill
*Cunningham, Bert, Ph.D., Prof. Biology, Trinity College............Durham
Dashiell, J. F., Ph.D., Prof. Psychology, Univ. N. C...............Chapel Hill
Daugherty, J. F., Dept. Physics, Univ. N. C......................Chapel Hill
Davis, Harry T., N. C. State Museum................................Raleigh
Denson, Lee A., Meteorologist, U. S. Weather Bureau.................Raleigh
*Derieux, J. B., Ph.D., Prof. Theoretical Physics, State College.........Raleigh
*Deviney; Ezda, Salem College.............................Winston-Salem
Deyton, J. W., Asst. in Botany, Univ. N. C.......................Chapel Hill

*Dixon, A. A., State College Station....Raleigh
*Eckert, J. E., Asst. Prof. Zool. and Entomology, State College....Raleigh
*Eddy, C. O., State College....Raleigh
*Edwards, C. W., Prof. Physics, Trinity College....Durham
Edwards, C. C., Dept. Mathematics, Univ. N. C....Chapel Hill
*Fant, Gordon W., Plant Pathologist, State College....Raleigh
Farmer, C. M., LL.D., Director of Extension....Troy, Ala.
Foster, N. B., Dept. Physics, State College....Raleigh
*Fritz, R. L., Prof. Mathematics, Lenoir College....Hickory
Frothingham, E. H., Director of Appalachian Forest Exp. Station....Asheville
*George, W. C., Prof. Histology and Embryology, Univ. N. C....Chapel Hill
*Givler, J. P., Dept. Biology, N. C. College for Women....Greensboro
*Goodhue, Miss Elva, Prof. Chem. and Physics, Greensboro College....Greensboro
Gould, H. N., M.D., Dept. Biology, Wake Forest College....Wake Forest
*Griswold, Miss Sylvia M., Dept. Biology, N. C. College for Women...Greensboro
*Gross, P. M., Ph.D., Prof. Chemistry, Trinity College....Durham
Gudger, E. W., Ph.D., Assoc. in Ichthyology, Amer. Mus. Nat. Hist....New York, N. Y.
Haasis, F., Forest Examiner....Asheville
Halverson, J. O., Ph.D., in charge feeding and nutrition, State Dept. Agriculture....Raleigh
*Hamlin, M. L., Ph.D., Asst. Prof. Chemistry, Trinity College....Durham
*Hartt, Miss Constance E., Inst. in Hygiene, N. C. College for Women..Greensboro
Hatley, C. C., Inst. Physics, Columbia University....New York, N. Y.
*Heck, C. M., Head of Dept. Physics, State College....Raleigh
*Henderson, Archibald, Ph.D , Head of Dept. Mathematics, Univ. N. C....Chapel Hill
*Heuser, Miss Clara, Dept. Home Economics, N. C. College for Women....Greensboro
Hickerson, T. F., Prof. Engineering, Univ. N. C....Chapel Hill
*Higgins, C. H., Head of Science Dept., Salem College....Winston-Salem
*Highsmith, J. Henry, State Dept. Education....Raleigh
Hill, M. A., Dept. Mathematics, Univ. N. C....Chapel Hill
*Hobbs, A. W., Ph.D., Prof. Applied Mathematics, Univ. N. C....Chapel Hill
Hoffman, S. W., Osteopath....Statesville
*Hogue, Miss Mary Jane, Ph.D., Prof. Bacteriology, N. C. College for Women....Greensboro
Holland, Miss Alma, Research Asst. in Botany, Univ. N. C....Chapel Hill
Holmes, J. S., State Forester....Chapel Hill
*Hook, A. L., Prof. Physics, Elon College....Elon College
Ives, J. D....Pine Bluff
*Ivey, Miss Rachel, Dept. Biology, N. C. College for Women....Greensboro
Ivey, J. E., State College....Raleigh
*Jacka, Miss Estelle, Dept. of Health, N. C. College for Women....Greensboro
Jenkins, Sanford S., Durham High School, Box 339....West Durham
*Jones, E. P., Industrial Research Fellow, Box 44....Durham
Jordan, W. E., Asst. Prof. Chemistry, State College....Raleigh

Kilgore, B. W., Director Exp. Station....Raleigh
*Korstian, C. F., Forest Examiner, Box 1518....Asheville
Kuhns, Miss Winifred M., Dept. Mathematics, Peace Institute....Raleigh
*Lake, J. L., Prof. Physics, Wake Forest College....Wake Forest
*Lasley, J. W., Ph.D., Assoc. Prof. Mathematics, Univ. N. C....Chapel Hill
Lehman, S. G. Asst. Plant Pathologist, State College....Raleigh
*Leiby, R. W., Ph.D., Entomologist, State Dept. Agriculture....Raleigh
Lewis, R. W., M.D., LL.D., Cit. Bank Bldg....Raleigh
Linderman, E. C., Dept. Sociology, N. C. College for Women....Greensboro
*Lyon, Miss Mary, Head of Dept. Biol., Greensboro College....Greensboro
Mabee, Bruce W., Div. Entomology, State Dept. Agriculture....Raleigh
McCall, F. E., Dept. Horticulture, State College....Raleigh
*Mackie, E. L., Asst. Prof. Mathematics, Univ. N. C....Chapel Hill
MacCarthy, Gerald R., Inst. Geology, Univ. N. C....Chapel Hill
MacNider, W. B., M.D., Prof. Pharmacology, Univ. N. C....Chapel Hill
Manning, I. H., Dean of Medical School, Univ. N. C....Chapel Hill
Markham, C. B, Prof. Mathematics, Trinity College....Durham
*Martin, A. C., State College....Raleigh
*Mendenhall, Miss Gertrude, Head of Dept. Mathematics, N. C. College for Women....Greensboro
Meserve, C. F., LL.D., Pres. Emeritus Shaw University....Raleigh
Metcalf, Z. P., Ph.D., Prof. Zoology and Entomology, State College....Raleigh
*Mitchell, T. B., Asst. Entomologist, State Dept. Agriculture....Raleigh
*Newlin, R. L., Prof. Math. and Physics, Guilford College....Guilford College
*Nixon, L. M., Asst. Feed Chemist, State Dept. Agriculture....Raleigh
Nowell, J. W., Ph.D., Prof. Chemistry, Wake Forest College....Wake Forest
*Noyes, Miss Bessie, Ph.D., Dept. Biology, N. C. College for Women...Greensboro
Patterson, A. H., Prof. Physics, Univ. N. C....Chapel Hill
Patterson, K. B., Prof. Mathematics, Trinity College....Durham
*Pegram, Annie M., Prof. Mathematics, Greensboro College....Greensboro
Pegram, W. H., LL.D., Prof. Emeritus Chemistry, Trinity College....Durham
*Petty, Miss Mary, Prof. Chemistry, N. C. College for Women....Greensboro
*Phillips, Charles, M.D., Prof. Pathology, Wake Forest College....Wake Forest
Pickens, Wiley M., Chemist....Salisbury
Pillsbury, J. P., Prof. Horticulture, State College....Raleigh
*Porter, W. L., Prof. Biology, Davidson College....Davidson College
Poteat, W. L., LL.D., Pres. Wake Forest College....Wake Forest
*Powell, T. E., Prof. Mathematics, Elon College....Elon College
Pratt, J. H., Ph.D., Director N. C. Geol. and Econ. Survey....Chapel Hill
*Preston, R. E., Dept. Physics, N. C. College for Women....Greensboro
Pritchard, R. S., Prof. Chemistry, Wake Forest College....Wake Forest
Prouty, W. F., Ph.D., Prof. Stratigraphic Geology, Univ. N. C....Chapel Hill
Ragsdale, Miss Virginia, Dept. Mathematics, N. C. College for Women....Greensboro
Randolph, E. O., D.Lit., Head Dept. Geology, College Station....Texas
*Randolph, E. E., Ph.D., Assoc. Prof. Indust. Chem., State College....Raleigh
*Rhodes, L. B., Asst. Chemist....Raleigh

Robinson, Miss Mary..Wadesboro
*Roller, A. F., Head Sci. Dept. in High School, 123 S. Dawson St........Raleigh
*Roller, J. H., Cary High School..Cary
Root, Mrs. J. C., Raleigh High School....................................Raleigh
Ruffner, R. H., State College..Raleigh
Satterfield, G. H., Grad. Student, Northwestern Univ.............Evanston, Ill.
*Saville, Thorndike, Assoc. Prof. Hydraulic and Sanitary
Engineering, Univ. N. C.....................................Chapel Hill
*Schaeffer, Miss Florence, Dept. Chemistry, N. C. College
for Women..Greensboro
Schallert, P. O., M.D., 349 Sprague St..........................Winston-Salem
*Seymour, Miss Mary F., Assoc. Prof. Biol., N. C. College for Women..Greensboro
*Shaeffer, Miss Blanche, Dept. of Home Economics, N. C. College
for Women..Greensboro
Sherman, Franklin, Entomologist, State Dept. Agriculture............Raleigh
*Sherrill, Miss Mary L., Asst. Prof. Chemistry, Mt. Holyoke
College..S. Hadley, Mass
Sherwin, M. E., Prof. of Soils, State College..........................Raleigh
*Sherwood, F. W., State Dept. Agriculture..............................Raleigh
*Shunk, I. V., Asst. Prof. Botany, State College.......................Raleigh
Smith, H. G., State College..Raleigh
Smith, S. C., Dept. Chemistry, Univ. N. C.........................Chapel Hill
*Speas, William E., Assoc. Prof. Physics, Wake Forest College.....Wake Forest
Stephenson, I. J., Inst. Mathematics, Univ. N. C..................Chapel Hill
Stiles, C. W., LL.D., U. S. Public Health Service...........Washington, D. C.
Strong, Miss Cora, Prof. Mathematics, N. C. College for Women....Greensboro
Stuhlman, Otto, Jr., Ph.D., Assoc. Prof. Physics, Univ. N. C........Chapel Hill
Sullivan, R. W., Dept. Chemistry, Wake Forest College...........Wake Forest
Taylor, C. C., Ph.D., Head Dept. Agric. Economics, State College........Raleigh
Taylor, J. H., Prin. Lowe's Grove High School, Route 3...............Durham
Taylor, W.F., Prof. Bact. and Hygiene, Wake Forest College......Wake Forest
*Thies, O. J., Asst. Prof. Chemistry, Davidson College.........Davidson College
Totten, H. R., Ph.D., Asst. Prof. Botany, Univ. N. C..............Chapel Hill
*Trice, M. F., State College..Raleigh
*Tucker, Miss Sallie, Dept. Biology, N. C. College for Women........Greensboro
Vann, H. M., Dept. Anatomy, Wake Forest College..............Wake Forest
Vaughan, G. W., Asst. Prof. Engineering, Trinity College.............Durham
Venable, F. P., Ph.D., Prof. Organic Chemistry, Univ. N. C.........Chapel Hill
*Vilbrandt, F. C., Ph.D., Assoc. Prof. Tech. Chemistry, Univ. N. C....Chapel Hill
*Walker, Ruth, Dept. Biol., N. C. College for Women...............Greensboro
Walker, Carl H., Teaching Fellow in Geology, Univ. N. C...........Chapel Hill
Weaver, R. S., Asst. in Geology, Univ. N. C......................Chapel Hill
*Wells, B. W., Ph.D., Prof. Botany, State College.......................Raleigh
*Wells, Mrs. B. W., Raleigh High School...............................Raleigh
Wessinger, C. E...Raleigh
*Wheeler, A. S., Ph.D., Prof. Organic Chemistry, Univ. N. C.........Chapel Hill
*White, Joseph D., Prof. Chemistry, Guilford College............Guilford College

*Wilkerson, N. F., Asst. Biology, Trinity College........................Durham
Williams, C. F., Asst. Horticulturist, W. Park Drive..................Raleigh
Williams, J. H., Raleigh High School......................................Raleigh
*Williams, L. F., Ph.D., Prof. Analyt. Chem., State College............Raleigh
*Williams, George A., Chemistry Dept., A. C. C........................Wilson
Williams, C. B., State College..Raleigh
Wilson, Donald B., State College...Raleigh
*Wilson, Henry V., Ph.D., Dept. Zoology, Univ. N. C................Chapel Hill
Wilson, R. B., Dept. Biology, Wake Forest College................Wake Forest
*Wilson, R. N., Dept. Chemistry, Trinity College.....................Durham
Winsor, A. S., Asst. Prof. Mathematics, Univ. N. C...............Chapel Hill
*Winston, Miss Lula G., Prof. Chemistry, Meredith College............Raleigh
Withers, W. A., Sc.D., Dept. Chemistry, State College.................Raleigh
Wolf, F. A., Ph.D., Dept. Botany, State College.......................Raleigh
*Wolff, W. A...Guilford College
Womack, A. W...Winston-Salem
Wood, W. W., C. E., Prof. Applied Math. and Astron., Davidson College...Davidson College
*Wright, Miss Eva K., Asst. Prof. Chemistry, N. C. College for Women...Greensboro
*Wright, W. T., Head Dept. Physics, N. C. College for Women.......Greensboro
*Yocum, L. E., Assoc. Prof. Botany, N. C. College for Women......Greensboro
Zoeller, E. V., P.D...Tarboro

Total number 200.

BERT CUNNINGHAM, *Secretary.*

PROCEEDINGS OF THE ELISHA MITCHELL SCIENTIFIC SOCIETY, OCTOBER 10, 1922, TO MAY 8, 1923

259TH MEETING—OCTOBER 10, 1922

H. V. WILSON—*Natural History Notes from Beaufort.*

The general character of the phenomena classed under the head of reduction was discussed on the basis of observations made at Beaufort during the past summer on hydroids and ascidians.

When the hydroid *Eudendrium carneum* is kept in laboratory aquaria reduction quickly affects the hydranths which become smooth, mouthless sacs bearing a general morphological resemblance to the planula larva and which fall off. Such bodies are not known to possess restitutive power. New hydranths are regenerated at the points where the old fall off.

The remarkable discoveries of Driesch on reduction and restitution in ascidians were described, and observations on these processes in *Perophora viridis* were reported. These latter dealt especially with the remodeling of pieces of stolon into little ascidians. A simple method of getting clean fresh stolons for experimentation was incidentally described.

FRANK C. VILBRANDT—*Some Problems in Lubrication.*

The problems of lubricant manufacture and lubrication resolve themselves into (1) the recognition of the refining problems, (2) the danger of overstressing motor gas production at the expense of the lubricating fraction, (3) the lack of knowledge of the lubricating principle in oils, (4) the absence of an ideal lubricant on the market today, (5) the inability to properly evaluate lubricants by present laboratory tests.

The possibility of correlating the action of the heat exposure to which oils are subjected in an internal combustion engine to that to which it is subjected in the flash and fire point tests in control work has suggested a new method for testing the stability of such an oil. The method, consisting of diluting the quenched residue from the fire test with pure gasoline and filtering the same through a clear filter

paper, produces results comparable with gravity viscosity, cloud, cold, distillation, flash and fire tests. The author recommends his test as a simpler solution to the evaluation problem.

Experiments were run on the viscometer, which measures the value of the oil as to its internal cohesion and its adhesive properties, for the purpose of determining the lubricating principle in oils, by mixing varying amounts of paraffin, paraffin oil and vaseline with a good engine oil. Results indicate that paraffin contained the minimum adhesive and the maximum internal cohesive properties and vaseline the reverse, or in other words that paraffin contributed nothing, but detracted from the lubricating value of an oil, while vaseline enhanced this value. It means that the lubricating principle is to be found in vaseline and that paraffins are devoid of it. The further identification of this principle is being studied in our laboratory.

ELECTION OF MEMBERS

The following members of the faculty were elected to active membership in the Society: Prof. F. H. Allport, Prof. E. T. Browne, Prof. R. E. Coker, Mr. J. N. Couch, Mr. H. D. Crockford, Mr. Clayton Edwards, Prof. E. G. Hoefer, Prof. Vernon Keyser, Mr. E. M. Knox, Mr. Gerald MacCarthy, Prof. R. B. McKnight, Dr. Simeon Nathan, Mr. K. B. Perine, Mr. S. C. Smith.

The following students were elected to Associate Membership: From the Department of *Botany*—A. W. Womack; *Chemistry*—W. L. Brown, Miss L. F. P. Cutlar, W. E. Giles, G. H. Leonard, G. R. Stout, T. K. Thomas; *Civil Engineering*—L. B. Aull, Jr., E. F. Engstrum, T. B. Gunter, R. C. May, J. G. Wardlaw; *Electrical Engineering*—T. W. Angel, W. C. Boddie, E. E. Dellinger, W. K. Harding, B. E. Humphrey, R. G. Koontz, W. C. Moore, R. C. Rike, H. L. Ross, T. Shepherd, C. U. Smith, C. R. Stroupe; *Geology*—H. C. Amick, J. V. Ambler, H. J. Bryson, E. B. Caudle, S. B. Troxler, C. H. Walker, R. S. Weaver; *Mathematics*—Mrs. Flora Harding Eaton, Z. T. Fortescue, Ira Hauser, H. Holderness, C. C. Smith; *Medicine*—J. M. Alexander, N. P. Battle, E. V. Benbow, M. P. Byerly, R. L. Carroll, G. C. Dale, R. K. Farrington, W. H. Harrel, R. H. Hofler, W. P. Holt, F. P. Hunter, E. E. Howard, W. S. Justice, H. T. Kelly, J. W. Kimbrough, E. M. Leake, W. E. Lennon, L. M. Little, B. A. Livengood, A. L. McAnnally, J. A. McLean, A. C. Norfleet, M. A. Roseman, K. C. Sasser,

W. J. Scruggs, H. C. Stillwell, R. W. Upchurch, H. J. Weaver, M. A. Widenhouse, J. G. Woodward; *Pharmacy*—J. L. Alexander, D. B. Kirtiker, J. E. Johnson; *Physics*—Wilton Cathey, Roy E. Cole, W. E. Comer, C. F. Smith, P. D. Stephenson; *Psychology*—F. M. Dula, H. A. Helms; *Zoology*—F. O. Glover, Charles Holshouser.

260TH MEETING—NOVEMBER 14, 1922

COLLIER COBB—*Permian Fossils from the Base of the North Carolina Newark.*

The sparsity of fossils at the base of what we call the Triassic in North Carolina is such that geologists have been unable to determine the age of the formation. Emmons, however, including in it everthing from the basal conglomerate and red sandstones, through the coal, fireclay, black band, and calcareous and bituminous shales, to and including the drab-colored sandstones just below the second conglomerate. Denison Olmsted, then a professor in the University of North Carolina, announced in the second volume of Silliman's *American Journal of Science* (vol. ii, 175, Nov. 1920) the discovery of a red sandstone formation in North Carolina, which he had traced through the counties of Orange and Chatham, with a breadth, in one instance at least, of about seven miles. Olmsted, in 1824, described a far more extended area of these rocks, and we know today that their extent is exactly as he mapped them at that time.

The Permian and Triassic of Emmons were by Kerr, 1875, grouped together as Triassic. Russell, in Bulletin 85 of the United States Geological Survey, prepared for the meeting of the International Congress of Geologists in 1892, applied to these rocks the name Newark System, Redfield, in 1856, having proposed the use of Newark Group.

Without reviewing farther the work done in these red sandstone areas, the present writer thinks that he has stratigraphical, lithological, and palaeontological evidence for the Triassic age of the greater thickness of these strata, though the conglomerates at the base, with the white, gray, or red sandstones lying immediately upon them he considers to be Permian; and the fossiliferous gray and drab slates at the top he has put down as transitional or Rhoetic. He has several times reported on these to this Society.

The studies on which these conclusions are based were begun in 1875, in Anson, while the writer was living in that county. The coarse sandstone associated with the basal conglomerate, is filled with silicified wood, the trunks of trees, but nowhere were the roots of these trees (conifers) observed. These show at Peachland (then Mulcahy) and near to Polkton; and they are also much in evidence near Chapel Hill. The white and gray sandstones of finer grain just above these yielded the ferns shown; and these few fossils are all recognized as typical of the Permian. They were found near Hornsboro, South Carolina. It was also from Hornsboro, in a stratum above these, that the writer obtained the two cycads reported to this Society in December 1894, as from the Triassic.

COLLIER COBB—*The Immediate Ancestor of Our Domestic Horse Found Fossil in Halifax County, North Carolina.*

In October Mr. F. M. Laxton, President of the Southern Radio Corporation, of Charlotte, and manager of a contracting company there, called my attention to some bones found in digging for the making of a cesspool at Enfield, and very kindly offered the assistance of his men in getting out the fossils. A few days later he published in the *News and Observer* a picture of a saurian of a type scrapped long before the Upper Miocene, the time of these deposits, as shown by the invertebrate fossils present with these bones. The picture was that of the *Plesiosaurus*, a marine reptile that lived in Jurassic and Cretaceous times.*

The bones that had attracted the attention of Mr. Laxton were really those of one of the many whales known in the Miocene deposits along Fishing Creek for a century past. The backbone of one of these creatures was for many years used as a footlog for crossing the creek from near the home of Mr. Applewhite, in Halifax, to the Edgecombe side. When excavating for the foundation of a bridge across this creek three years ago the workmen unearthed several bones to which Mr. Frank Page called my attention. I visited the place and brought several of the bones to Chapel Hill. Nearly two years ago Dr. W. F. Prouty obtained a number of these whale bones from a locality on the same creek.

On my recent visit, besides obtaining some additional specimens of the whale bones, I have found the left tibia of a horse, a find of

* For this picture see J. W. Gregory's "Geology of To-day," opp. p. 260.

exceeding great interest, since it shows the presence of a well-differentiated horse in late Miocene, or St. Mary's deposits, in North America. The stratum from which this bone was taken is a layer of blue clay literally filled with the shells of *Scala*, so thoroughly characteristic of the St. Mary's formation.

The horse family (*Equidae*, from *Equus caballus*, the living horse) appeared almost simultaneously in Europe and America in the dawn horse (*Eohippus*) early in the Eocene, but it was in North America that this group of animals passed through the greater part of their later development. In Europe the horses died out in the Eocene, and Asia was restocked from America by way of Siberia early in Miocene time. Late in the Miocene the horse of North America spread into South America. In the American Pleistocene there were many species of *Equus*, but the immediate ancestor of our domestic horse was not among them, and the entire tribe vanished in the later part of this period. The living species originated in Europe or Asia, so it has been believed, and was introduced into this country by the Spaniards.

There is no stock of animals better known than that of the Horses, and they have become the classic example or show animal of evolution. In fact, the famous Yale University collection assembled by Professor Marsh, and now duplicated in several places, did much to demonstrate the truth of Darwinism. The lower Eocene horses were about the size of a cat or a fox-terrier, and they ranged by slow gradations from these diminutive creatures to the great animals of Pleistocene time, about fourteen hands high. This bone from Enfield belonged to an animal about the size of a Hatteras pony, and may have been the immediate ancestor of our domestic horse, hitherto unknown in America. It is interesting to note in this connection that the first warm-blooded animal—the *dromatherium*—was found in Chatham County, North Carolina.

A. S. WHEELER—*Some New Dyes.*

Dr. Wheeler with the assistance of Mr. B. Naiman has extended the bromohydroxynaphthoquinone field. An improved method was worked out for the preparation of the monobromo derivative of juglone. This compound was converted into the dibromo derivative and the latter into the monobromohydroxy derivative. Their acetyl and benzoyl derivatives were made. These substances contain a quinoid complex, also an hydroxyl group and therefore are dyes, producing

shades of tan. With the aid of Mr. I. V. Giles the para-cymene was further explored. A new compound, 2-amino-5-chloro-p-cymene, was prepared and many new dyes were made by coupling it up with phenols and naphthols of different kinds by means of the diazo reaction. Some of these dyes owing to the presence of the chlorine atom are of especial beauty and brilliance.

261ST MEETING—DECEMBER 12, 1922

T. F. HICKERSON—*Transition Spirals for Highways: a New Method.*

The alignment of highways consists of straight lines and arcs of circles. At the junction of the two, there is an abrupt change of curvature from zero to the full amount of that of the circle; in other words, there is a sudden change from a curve whose radius is infinity (a straight line) to a curve whose radius is in extreme cases as small as 80 feet. A transition spiral provides a gradual change from the one to the other. It is a curve whose radius varies as the distance from the point where it leaves the tangent to the point where it coincides with the circle. Sharp curves should be banked, that is, elevated on the outer surface; and obviously this too should be done gradually.

If the radius of the circle is larger than 500 feet, there is no special demand for a transition or easement spiral so far as avoiding a lurch is concerned, but spirals afford long approaches to curves, and they therefore add much to the aesthetic appearance of highways, as well as lessen distances; this last advantage means many dollars saved when designing hard surfaced roads at several dollars per square yard.

In every case of a change in direction along highways, where ample distance is available for long approach tangents, it is the opinion of the writer that the most perfect alignment consists of two spirals coinciding at the center of the curve. Where tangent distance is limited, a combination spiral and circle should be used if possible. In extreme cases, as in mountainous country, curves occur so close together that only circles (widened at the center) can be used.

The equations dealing with spirals are very complex and uninviting to the engineer in the field. It has been the purpose of the writer to simplify the method of application to highway location, since all the literature on the subject at present relates to railroad curves. By the aid of tables compiled by the writer, spirals may be laid out in several ways with as much ease as in the case of ordinary circular curves.

Tables and formulae for the extra area of pavement due to widening the roadway around sharp curves enable one to obtain exact results with no difficulty.

The complete method will be published soon in the form of a handbook suitable for the engineer in practice.

FLOYD H. ALLPORT—*Facial Expressions and How We React to Them.*

The explanation of the origin of the emotional expressions and their connection with emotions is still obscure. Darwin's theory asserts that they are expressive vestiges of ancestral habits once serviceable to life in some other way. Facial expression is not the original function of the facial muscles. Another view, that of Piderit and Wundt, points out the analogous nature of facial expression. We react for example to a situation that causes us ill feeling with the same bitter expression that we assume when tasting a bitter substance. Language contains many such "synonyms of expression." Is there a common bodily "set" or attitude which carries over from the primitive sense experience to the later emotional situation?

The facial musculature comprises a number of sets of antagonistic muscles which render it impossible, for example, to raise and lower the corners of the mouth at the same time. This mechanism underlies two elementary affective expressions seen in smiling and weeping respectively; these expressions being antagonistic, identifiable as bases for more complex emotions, and occurring (either one form or the other) in all facial expression of emotion. Subjectively, their counterparts, pleasantness and unpleasantness, may be recognized in all conscious emotional states. Other muscles serve to differentiate the specific kind of pleasant or unpleasant emotion involved. For example, the nose in disgust is shortened and in grief is lengthened. A convenient chart summarizing these differentiating expressions was presented showing the typical attitudes of brows, eyes, nose, mouth, lips, lower jaw, and head, in the emotions of pain and grief, amazement and fear, anger, disgust, and pleasure.

The study of our responses to facial expressions involves interesting problems. For recognition of the ordinary strong emotions by photographs of actors' poses experimentation shows the general accuracy to be between forty and fifty per cent. The most effective method used in this identification is that of recalling life situations with which the expressions in question are readily associated. Again,

the question arises as to whether ability in recognizing facial expressions is an inherited or an acquired capacity. An experimental study by the writer, in which an expression-naming test was given both before and after study of the chart mentioned above showed a correlation between original score and gain through study of —.86. This seems to indicate that the ability to identify emotional expressions is an acquired rather than an inherited ability. Finally, the problem as to the exact factors in development of this ability is a complex one, probably involving fine discernment, intelligence, opportunity, and an objective attitude toward the world.

262ND MEETING—JANUARY 9, 1923

J. W. LASLEY—*A Problem in Projective Differential Geometry.*

In a former paper it has been pointed out that Klein's classification of geometry from the standpoint of groups leads, among others, to a kind of geometry called projective, characterized by the invariance of such things as the order and class of a curve, collinearity and coplanarity of points, coplanarity and concurrence of lines, etc. Projective geometry, on the other hand, leads to sub-classification called differential and integral, depending respectively upon whether a limited portion or the entirety of a geometric configuration is to be considered.

The present paper concerns itself with some of the results obtained from considering a problem in the field of projective differential geometry. A tangent plane meets a surface in a curve which has a double point at the point of contact. Double points which are also points of inflection are called flecnodes, a name due to Cayley. The tangents at such double points are asympytotic tangents. For a ruled surface there are ordinarily two such points on each generator. One of the asymptotic tangents is a generator of the ruled surface. The other generates a ruled surface which is called the flecnode surface. It is a surface of two sheets, though not necessarily bipartite. These sheets are called the first and minus first flecnode transforms of the original ruled surface. Wilczynski has shown that the minus first transform of the first transform is the original surface. The first transform of the first transform ordinarily leads to a new surface. Continuing in this way we have a suite of ruled surfaces which is called the flecnode suite. Questions arise as to whether

this suite terminates or is periodic. It is found that a necessary and sufficient condition that the flecnode suite terminate with its first transform is that the given ruled surface have a straight line directrix. The equations of the most general curve which can serve as the second branch of the flecnode curve of a ruled surface with a straight line directrix can be obtained without integration. A necessary and sufficient condition that the flecnode suite terminate with its second transform is determined. It turns out to be the vanishing of an invariant of weight thirty. The equations of both branches of the flecnode curve on a ruled surface may be determined without integration if the flecnode suite terminates with its second transform. The flecnode suite is of period two, when, and only when, the flecnode curve meets every generator in two coincident points, or is indeterminate. The flecnode suite cannot be of period three, nor of period four.

A. H. PATTERSON—*A New Process of Lead Coating.*

Secretary Hoover is quoted as saying that next to the fire loss in this country is the rust loss. Many methods are employed to protect surfaces—electroplating, dipping, varnishing, painting, etc. All of these methods are unsatisfactory for one reason or another, expense or otherwise. The new method was described as a process of coating metals with lead. As the process is a secret one, no details could be given, but samples were submitted showing the results. One interesting thing about the process is that the lead seems to form an alloy with the metal on which the coating is laid. For this reason the trade name of the process is Intraloy. As far as could be done with propriety, Professor Patterson described the tests made on this process last summer while he was in the employ of the company that is developing this process. The process bids fair to be of immense usefulness.

263RD MEETING—FEBRUARY 12, 1923

JOHN D. CAPRON— *The New de Lavaud Method of Making Cast Iron Pipes by a Centrifugal Process.* (By invitation).

Mr. Capron, of the United States Cast Iron Pipe and Foundry Company, presented an interesting and instructive talk on the new de Lavaud method of making cast iron pipes by a centrifugal pro-

cess. The lecturer accompanied his talk by moving pictures. These showed first the difficulties and trouble consequent upon the old sand mold method of making cast iron pipe, which has been in use for over two centuries, the first cast iron pipe having been laid to supply the fountains of Versailles in the time of Louis XIV. Until about ten years ago no improvement had been made in this process.

The new centrifugal process consists of a cupola, a revolving, water-cooled molding machine, an annealing furnace, and a dipping vat. The ladle discharges its contents into a cantilevered water-cooled trough, which projects into the interior of the revolving mold, and from the forward end of which iron is discharged in a stream parallel with the plane of revolution. The machine includes a hollow cylindrical mold, revolved by a water-wheel. The mold is enclosed, and travels back and forth on inclined ways. The mold rotates at 1600 revolutions per minute, and a complete pipe is poured, cast, and cooled sufficiently to take from the mold in three minutes.

From the mold the pipe goes to an annealing furnace and thence to a dipping vat to re-coat it with tar.

The centrifugal pipe is lighter (per foot), denser, thinner, and much stronger than the pipe cast by the old process.

264TH MEETING—APRIL 10, 1923

ARCHIBALD HENDERSON—*Einstein's Finite, Unbounded Universe.*

The classic theory of Newton presumes that the universe is infinite in extent, and that the mean density of matter is infinitesimally small. This theory makes our "island universe," which by constant loss of radiation and stellar matter, is a gradually dying universe. In the effort to arrive at a more satisfactory conception, in accordance with the General Relativity Theory, Einstein examines various hypotheses on the assumption of an infinite universe; and was compelled to reject them. Finally on the assumptions: (1) the mean density of matter was an appreciable quantity, (2) that the universe was finite but unbounded; and (3) that the matter in the universe was virtually at rest (as compared with the velocity of light), Einstein on the basis of the General Relativity Theory concluded that the space in which we live was "spherical" in the Riemann sense. He found the radius, volume, mass, and weight of the material universe in terms of the presupposed (value unknown) value of the

mean density of matter. Dr. Henderson presented the results of certain investigations carried on in the advanced seminar on General Relativity which he conducted here this year, giving figures and computations for the size of the universe, on the assumption that the mean density of matter was the same as that of the Milky Way. For example, the radius of the "spherical" space universe of Einstein was found to be one million times one billion times the distance from the earth to the sun. It was found that a ray of light travelling at the rate of approximately 186,000 miles per second would go around this universe in one billion years. These and other results were given to convey some notion of the size of the universe worked out upon the basis of Einstein's results.

OTTO STUHLMAN, JR.—*Radiations Lying Between the Ultra-Violet and X-Ray Spectrum.*

It was found that when thermions liberated from a tungsten filament were accelerated and allowed to impinge on a metal grid maintained at a variable positive potential that secondary electrons were emitted from the grid. The number of such secondary electrons emitted were measured by means of a galvanometer in series with the grid and a plate maintained at a constant positive saturation potential.

On plotting the secondary current as a function of the accelerating voltage acting on the primary electrons, a sudden change in the slope of the curves occurring at critical potentials were interpreted as V (volts) x L (Aengstrums) = 12320.

The critical voltages at which emissions occurred were found to be: Tungsten 4.4, 17, 35.6, 60, 135, 144, 181, 295, 435, 1750. Iron: 3.3, 8.5, 10.4, 24.3, 45.8, 200.

265TH MEETING—MAY 8, 1923

DR. IVEY F. LEWIS, Exchange Professor from the University of Virginia (U. N. C., class of 1902)—*The Age and Area Hypothesis.* (By invitation).

The hypothesis known by this name was proposed by Willis in 1907 and has since been somewhat modified and enlarged in numerous papers. It is thus stated by its author:

"The area occupied (determined by the most outlying stations) at any given time, in any given country, by any group of allied

species at least ten in number, depends chiefly, so long as conditions remain reasonably constant, upon the ages of the species in that country, but may be enormously modified by the presence of barriers such as seas, rivers, mountains, changes of climate from one region to the next, or other ecological boundaries, and the like, also by the action of man, and by other causes."

In spite of the qualifications in the statement, many of which followed extensive criticism, the principle has been found to hold good in many countries, being especially well shown in Ceylon, New Zealand, and other islands. It has been possible on the basis of the principle for the author to make many predictions, subsequently verified, as to the distribution of plants in many parts of the world, and to draw interesting and important conclusions as to the history and phylogeny of some plant species.

The author is of the opinion that the rapid distribution of weeds is a phenomenon following and consequent upon the disturbance of natural conditions by man. In the absence of such disturbance, the distribution of plants takes place slowly and with a certain uniformity, so that it is possible to treat the phenomena of distribution with mathematical precision. Such treatment may be expected to throw, and has already thrown light on general problems of the first importance, such as the development of phylogenetic lines and the origin of species.

ELECTION OF OFFICERS:

President—A. S. Wheeler.

Vice-President—R. E. Coker.

Permanent Secretary—J. M. Bell.

Recording Secretary and Treasurer—H. R. Totten.

Editorial Committee—W. C. Coker, Chairman; J. M. Bell, Collier Cobb.

H. R. TOTTEN, *Recording Secretary.*

DEDIFFERENTIATION IN HYDROIDS AND ASCIDIANS*

By H. V. Wilson

Eudendrium colonies (*E. carneum* Clarke) kept in aquaria, at Beaufort, N. C., during August (1922), dropped their hydranths in the course of twenty-four hours, new ones in many cases being later regenerated from the ends of the hydrocaulus system. Before the hydranth is constricted off the tentacles shorten and fade away into the body, the mouth closes, and the demarcation between hypostome and the rest of the hydranth disappears. The hydranth is thus converted into a smooth, ellipsoidal, thin walled, and often swollen sac, which drops off. These "planuloid" bodies in the actual experiments died without evidencing regenerative power. In July (1910) hydranths of the same species, cut off at the base from the hydrocaulus and kept in aquaria, were observed to undergo in about the same time a similar series of dedifferentiative changes; the resulting planuloids were globular.

This series of changes is closely parallel to that exhibited by starving hydras (Schultz, Archiv f. Entw.-Mech. 1906), except that testes commonly develop in the latter. The changes as recorded for other hydroids are somewhat different. In *Campanularia* (Thacher, Biol. Bulletin, 1903) the hydranth, while going through much the same anatomical phases, retains its connection with the stem, into the gastric cavity of which its tissues, in the shape of degenerating and dissociated cells, pass. Thus ultimately the whole mass of the hydranth is used up as food. Thacher finds that essentially the same process of degeneration and absorption as food material is undergone in other Woods Hole species (*Eudendrium* and *Pennaria*). In *Tubularia* (Morse, Biol. Bulletin, 1908-09), at Woods Hole, the hydranths fall off in confinement while yet practically normal in appearance.

What in a gross way, at least, presents itself as a case of "reduction" may also be observed in male gonosomes of *Eudendrium carneum*. A male gonosome consists of the expanded end of a branch, representing an aborted hydranth, bearing a whorl of radially pro-

* I am indebted to the U. S. Commissioner of Fisheries for a working place in the Laboratory of the U. S. Bureau of Fisheries at Beaufort, N. C., where the observational work recorded in this paper was carried on.

jecting gonophore-strings. Each string consists of several, often 3-5, gonophores, following on one another in a long single row. A number of such gonosomes were amputated at the base from the rest of the colony (July 30, 1910) and were kept in laboratory dishes. The gonophores burst one after another, liberating sperm. This continued during the next three days until most of the strings had been transformed into short, hollow lobes, projecting like tentacles from the aborted hydranth which was now considerably larger and better marked off from the stem than it originally was. The mortality among the amputated gonosomes was high and in the actual experiment only a few reached the stage just described. These were preserved (Aug. 2). One especially gave clear evidence that the tentacle-like lobes were being absorbed into the body of the hydranth. In the case of some of the strings of gonophores all the gonophores had not burst at the closing of the experiment; such strings remained as hollow tentacle-like lobes each with a single terminal gonophore. Doubtless the reduction of the gonosomes can be made to go farther than it was carried in the actual experiment.

A number of years ago some of Driesch's experiments (Archiv f. Entw.-Mech. 1902, 1906) on reduction and restitution in simple ascidians were repeated at Beaufort, N. C., on *Perophora viridis*. Driesch used *Clavellina*, as did Schultz (Archiv f. Entw.-Mech. 1907) in his later study. Huxley in his recent work (Quart. Journ. Micr. Sci. 1921) along the same line used *Perophora*. At Beaufort I was able to make the following mainly confirmatory observations.

Very small pieces of young fresh stolons, grown in the laboratory, were pinched off with needles in such a way as to attach the pieces, which were no longer than wide, to the cover. The attachment was strengthened by draining the cover as it was passed to each new bowl of fresh sea water. Of four pieces thus prepared (July 7, 1910), three died but one transformed in three days into a little ascidian with open retractile siphons; the heart was beating vigorously on the second day. The piece of stolon was so small that it was all used up directly in forming the ascidian body, the process being one not of budding but of morphallaxis.

An effort was made to test the regenerative powers in vitro of mesenchyme cells pressed out of the stolon. Clumps of cells sticking

together and to the slide were obtained. These died within a day. It should be added, however, that no special precautions were taken against bacterial growth.

Thirty-four pieces, 1 to 3 but mostly 2 mm. long, of fresh stolon were cut July 7 (1910). A considerable number of these pieces within two days (July 9) developed a terminal or lateral bud, into which in a number of instances the stolon two days later (July 11) had been largely absorbed, as has been recently described by Huxley.

Of great interest is the question how far reduction may be made to go in these animals with retention of regenerative power. Employing the simple method by which I obtained in sponges gemmule-like masses of regenerative tissue scattered through the dead body (Science, June 7, 1907), I allowed a dozen *Perophora* to die slowly in aquaria in the hope that viable masses might be formed. All but one died completely. But in the case of this one within the tunic and débris of the original animal, a week after the inception of the experiment, a conspicuous mass of live tissue remained. This was of a bright greenish yellow color, apparently solid, irregularly lobed, and about 0.350 mm. in total diameter, the width of the lobes 0.220 mm. to 0.090 mm. It would be of interest to work out the origin and test the regenerative Gesellsch. Naturf. Freunde zu Berlin, No. 6, 1907) on the formation of winter buds in *Clavellina* probably have a bearing in this connection.

CHAPEL HILL, N. C.

SOIL TREATMENTS TO OVERCOME THE INJURIOUS EFFECTS OF TOXIC MATERIALS IN EASTERN NORTH CAROLINA SWAMP LAND

By M. E. Sherwin

Location of the Specific Area

The area to be specifically discussed is situated on the Nissen Farms at Terra Ceia in Beaufort County, North Carolina. This area has been drained by canals and open ditches for several years and has produced eight or ten crops.

Soil Characteristics

The soil is deep peat, about 90% organic. The surface is loose and open but the soil passes at a depth of six to eight inches to a soggy, lighter brown material with a capillary water capacity of from 400% to 650%. At the close of the dry summer of 1921 samples taken from the field were found to have approximately 265 per cent of water. These high percentages are held by capillarity but the water may be squeezed out as from a sponge by pressure. After being dried, the soil reabsorbs water slowly and to a relatively slight extent as shown by the following:

Water held as taken from the field	264.93%
After being oven dried and then allowed to stand 4 days in water	18.30%
Same soil after standing 12 hours in water at 80°C. absorbed additionally	41.22%
Total absorbed	59.52%

The lime requirement as reported by the Bureau of Soils is slightly in excess of one ton $CaCO_3$ per acre inch. The pH values as determined in the soils laboratory at the N. C. State College, vary from 3.5 to 5.

Crop Characteristics

Spots designated as "poor" appear irregularly scattered without any obvious physical differences in the soil; yet the crop difference is very great almost to a line.

The nodal tissues of corn growing in the field are more or less discolored, and the discoloration is particularly noticeable in the "poor" spots. This discoloration has been attributed by Dr. G. N. Hoffer to accumulations of iron.

PLAN OF EXPERIMENTAL WORK

The experiments discussed here were outlined by Mr. R. W. Howell, manager of the Nissen Farms, and have been conducted as a private enterprise. The writer has acted in the capacity of advisor since the fall of 1921. The experiments have been carried on one year. They consist of 13 cultural treatments which are crossed by limestone in varying amount; by fertilizers and manure in constant amount on both limed and unlimed blocks, and by checks.

RESULTS AND DISCUSSION

When the reaction to drying noted above was observed the writer recommended ridging of the land so as to allow a maximum of field drying. This cultural treatment has resulted in an increase in the corn crop of from 20% to 100% per cent with an average of 45% over flat breaking. Average results from fertilizer treatments are shown below.

TABLE 1. PER CENT INCREASE IN CORN WITH DIFFERENT FERTILIZER TREATMENTS

	Average Increase
Kainit (480 lbs. per A.)	20%
Limestone and kainit	50%
Limestone (1 to 4 tons per A)	1%
Nitrate of soda (160 lbs. per A)	40%
Nitrate of soda and limestone	40%
Nitrate of soda and acid phosphate—loss	4%
Nitrate of soda and phosphate and limestone	37%
Nitrate of soda and kainit	56%
Nitrate of soda and kainit and limestone	60%
Nitrate of soda Kainit Acid phosphate	39%
Nitrate of soda Kainit Acid phosphate Limestone	49%

Kainit and acid phosphate 21%
Kainit, acid phosphate and limestone 44%
Acid phosphate (320 lbs. per A)—loss 20%
Acid phosphate and limestone—loss 6%

The outstanding features of this tabulation are the depressing effect of acid phosphate, except where used with kainit alone and the stimulating effect of kainit wherever used. Nitrate of soda has given remarkable results alone and has added, in every case, to the beneficial result from kainit but has not overcome the depressing effect of acid phosphate. Kainit alone has overcome this depressing effect in every combination. Limestone has given stimulative effects in every combination except with nitrate of soda.

Tabulating these effects, we get the following:

TABLE II. PER CENT INCREASE DUE TO FERTILIZER AT TOP OF COLUMN WHEN ADDED TO SOIL WITH COMPOUND OR COMBINATION OF COMPOUNDS AT SIDE

	Kainit	Limestone	Nitrate of Soda	Acid Phosphate
N*	16	0		44 loss
P	41	15	16	
K		30	36	1 loss
L	49		0	7 loss
NP	43	41		
NK		4		17 loss
NL	20			3 loss
PK		23	18	
PL	50		43	
KL			10	6 loss
NPK		10		
NPL	12			
PLK			5	
LNK				11 loss
Total	231	123	128	89
Average	33	18	18	13

*N—Nitrate of soda, 160 lbs. per A.
P—Acid phosphate, 320 lbs. per A.
K—Kainit, 480 lbs. per A.
L—Limestone, 1-4 tons per A.

Let us now note the relation between the effects of these treatments on yield and their effects on discoloration of the nodal tissues of the

corn plant which discoloration is apparently due to accumulation of iron within the plant. If we are able to establish this relationship, then we shall be able to discuss intelligently the physiological effect of the fertilizers used.

The following table was made by Dr. G. N. Hoffer, working at Purdue University, to show the relative discoloration of nodal tissue in plants sent him by Mr. Howell. (The figures at the right and bottom are mine).

TABLE III. RELATIVE AMOUNTS OF IRON IN THE NODAL TISSUES OF CORN STALKS FROM THE NISSEN FARMS, TERRA CEIA, N. C., AUGUST 1, 1922

Treatment	Tons Limestone Per Acre					
	0	1	2	3	4	
Ck	+ + +	+ +	+ + +	+ +	+ +	12
N	0	+ +	+	+	+	5
P	+ +	+ + +	+ + +	+ + +	+ + + +	15
K	0	+	+	0	+	3
NP	+ + +	+ + +	+ +	+ + +	+ + +	14
NK	0	0	0	+	0	1
PK	+	0	+	+	+	4
NPK	+	+	0	+	0	3
M	+ +	+	0	0	+ + +	6
	12	13	11	12	15	

Nodal tissue condition:

0—normal.

+—slight purple color.

++—purple brown.

+++—Dark purple brown and disintegration of nodal tissue.

Note the marked effect of the kainit and of the nitrate of soda in the reduction of discoloration; also the effect of the acid phosphate in the increasing of the discoloration. The figures at the right and the bottom are the total number of checks in the respective columns

and hence represent the relative iron accumulations. Summarizing the data in this table, as we did in Table I, we get results which are here compared with the average of Table II.

TABLE IV. AVERAGE DEPRESSION OF IRON ACCUMULATION IN NODAL TISSUES OF CORN COMPARED WITH INCREASES IN YIELD

	Average depression of iron accumulation	Average increase in yield
Kainit	9 —	33
Nitrate of soda	4 —	18
Acid phosphate	4 — (accumulation)	13 — loss

From this, we see that the increase in yield is roughly in proportion to the depression of iron accumulation and we assume that the toxic material present in the soil is soluble iron.

What is the action of the fertilizer materials in preventing excessive accumulation of iron and how do they function in increasing crop yields? Hoffer[1] states that root rot is related to metal poisoning and that the greater the accumulation of iron within the tissues the greater the damage from root rot. Any treatment therefore which keeps the iron out may be expected to decrease root rot and increase the yield of corn. The observed facts are that the discoloration due to iron is less and the yield greater when kainit and nitrate of soda are used, and that the discoloration is greater and the yield less when acid phosphate is used. True[2] has shown that the lupine, which is in the same group as corn, with regard to its acidity-growth relationships has considerable difficulty in the seedling stage in absorbing the $\overset{+}{K}$ ion unless certain combinations of ions or salts are present. He finds that the $\overset{++}{Ca}$ ion, the NO_3 ion and presumably the $\overset{-}{Cl}$ ion aid the absorption of potash and that the $\overset{--}{SO_4}$ ion and the $\overset{-}{H_2PO_4}$ ion interfere with its absorption.

We are led, therefore, to conclude as follows regarding the action of the fertilizing materials used:

1. Kainit aids the crop, presumably on account of the effect of its potash on the entrance of iron into the plant. Potash appears to enable the plant to withstand otherwise toxic amounts or compounds of

[1] Hoffer, G. N. From correspondence with the Nissen Farms.

[2] True, Rodney H. The function of calcium in the nutrition of seedlings. In Jour. Amer. Soc. of Agronomy, Vol. 13, No. 3, 91-107, March 1921.

iron. The chlorine of kainit aids the passage of potash into the plant. The sodium of kainit furnishes a base to combine with nitrates produced by nitrification, the resulting compound being not only non-toxic, but stimulating and a direct plant food. The combination of sodium with nitric acid reduces the amount of ferric nitrate which may be formed. Kainit, therefore, supplies potash both directly and indirectly; reduces the amount of soluble iron; and increases the non-toxic nitrates.

2. Nitrate of soda aids potash into the plant; supplies a beneficial nitrate; and depresses nitrification so that an excess of ferric nitrate is not presented to the plant.

3. Acid phosphate retards the entrance of potash into the plant, hence aids in the accumulation of toxic iron.

4. Lime at the rate of 2 or 3 tons per acre has given better results than more or less. This appears to be due to the synergistic effect of calcium on potash. A smaller amount of lime is probably insufficient for this purpose. A larger amount is not needed for this purpose and probably stimulates nitrification with formation of excessive ferric nitrate. There appears to be no direct relation between the effect of lime and the lime requirement of the soil as determined by the Veitch method.

The effect of lime on the ridged land is not significant. Lime is probably without value because the ridged land is aerated to a point where it will not retain soluble iron.

RALEIGH, N. C.

CONTRACTILE VACUOLES IN AMOEBAE—FACTORS INFLUENCING THEIR FORMATION AND RATE OF CONTRACTION

By Mary Jane Hogue

The presence of contractile vacuoles in protozoa, has long been known. It is stated in most text-books that a contractile vacuole is usually present in the fresh water protozoa and generally absent in salt water protozoa. All the protozoan parasites in the intestine of man are without contractile vacuoles and many protozoan parasites in the intestines of other vertebrates are without them. This is especially interesting when one considers that the sodium chloride content of the digestive tract varies in the different vertebrates, but is always much below that of sea water, which is often 3.04 per cent; though this varies with the locality.

Formation of Contractile Vacuoles

While working at Woods Hole with *Vahlkampfia calkensi,* which are parasitic in the digestive tract of the oyster and consequently used to water of considerable sodium chloride content, I succeeded in keeping them several days on agar medium made up with tap water and with distilled water. These amoebae developed a contractile vacuole similar to that of fresh water amoebae (Hogue 1). The experiment was repeated many times and frequently the amoebae lived five or six days on agar made up with fresh water.

The following method was used: The amoebae were grown on sterile agar made up with sea water or with 0.7 per cent sodium chloride solution. Here they multiplied rapidly. From such a culture in Petri dishes, a small block covered with amoebae was cut out and transferred to a Petri dish containing agar made up with distilled water. A small loop full of 0.7 per cent sodium chloride solution was added to the transfer and seemed to facilitate the movement of the amoebae and also to prevent the small block of agar from drying.

At the end of 24 hours the amoebae were leaving the transplant and wandering out onto the new medium, going only as far as the

bacteria, which served as their food, had spread. The following days they wandered still further from the transplant but were always within the zone of bacterial growth. Food vacuoles were present and a contractile vacuole appeared and pulsated. Pseudopodia were forming and the animals were moving about slowly.

Slides were made from these cultures. Many amoebae were put on a slide. They were fixed with Schaudinns solution and stained with iron haematoxylin in the usual way (Hogue 1), but with very different results. Many of these amoebae did not stick to the slide, so that only a few were finally stained and mounted. The amoebae seemed to have lost their power of adhesion when they were transferred from a salt water medium to a fresh water medium.

This is interesting when one compares it with Zuelzer's (2) results. The two experiments are the reverse of one another. She took *Amoeba verucossa* from fresh water to sea water and found that in its new medium it lost its power of adhesion. This loss of power of adhesion must be due to some change in the physiological condition of the amoeba due to the change from a medium of one salt content to that of another salt content.

In another respect the two amoebae, in their new media are similar. *Vahlkampfia calkensi* seemed to feed. It had food vacuoles full of bacteria. *Amoeba verucossa* also had vacuoles containing partly digested food.

On the other hand, *Amoeba verucossa* in salt water did not form pseudopodia and did not move forward. It rolled around but did not cling to the glass, whereas *Vahlkampfia calkensia* formed pseudopodia and moved out over the new medium.

Amoeba verucossa in salt water lost its contractile vacuole while *Vahlkampfia calkensi* in fresh water formed a contractile vacuole. Neither amoeba reproduced in its new environment.

When we consider that one function of a contractile vacuole is to regulate the osmotic pressure of the protoplasm it is to be expected that a contractile vacuole will be formed and function when the amoebae are taken from a medium with high sodium chloride content to one free from sodium chloride.

MULTIPLE CONTRACTILE VACUOLES

In one experiment when *Vahlkampfia calkensi* were taken from agar made up with sea water to agar made up with distilled water, they developed two, three and even four vacuoles. These contracted sometimes synchronously, sometimes at different rates.

The presence of two or more contractile vacuoles seems to be quite abnormal for amoebae. Hance (3) has noted the presence of multiple contractile vacuoles in a certain line of *Paramoecium caudatum*, and thinks it may be due to the fact that the paramoecium had been exposed to high temperatures (40° C). In his experiments the extra contractile vacuoles were passed on from generation to generation with some variation in the inheritance.

Calkins (4) suggests that an extra number of contractile vacuoles may be due to a lowered vitality. This explanation seems applicable to the case of *Vahlkampfia calkensi* which were certainly in a state of lowered vitality as was shown by the fact that they were not reproducing. The bacteria on which they lived multiplied very rapidly and the amoebae were soon crowded out and died.

RATE OF PULSATION OF CONTRACTILE VACUOLES

It has been suggested by several investigators that the rate of pulsation of the contractile vacuole is probably influenced by the surrounding medium. A good opportunity to study this offered itself at Woods Hole when I was growing a *Limax* amoeba on media of different densities to see what their effect would be on its shape (Hogue 5). Small pieces of agar containing amoebae were removed from the Petri dish to a slide so that the amoebae were not disturbed and so as to be able to study them with a higher magnification than was possible when focusing through an inverted Petri dish. Ten successive readings of the time of contraction of the vacuole in seconds were made and the average calculated for each amoeba. These readings were then averaged for the amoebae on each specific medium as shown in the following table.

% of Agar	No. of Amoebae Used	Average Rate of Contraction
0.5	22	59.75
1.0	3	(67.83)
1.5	13	44.8
2.0	10	44.95
2.5	19	43.8

The table shows a discrepancy in the rate of contraction of the vacuoles in amoebae grown on 1.0 per cent agar. This is due to the condition of the amoebae which were studied. The culture was not in a flourishing condition so that only a few amoebae could be obtained and the rate of contraction of their vacuoles was much slower than the rate in any of the other amoebae studied. In other respects there is a gradual increase in the rate of contraction of the vacuoles when the amoebae grown on 0.5 per cent agar are compared with those grown on 2.5 per cent agar.

This increase in the rate of contraction of the vacuoles when amoebae are on a denser medium may be due to an attempt on their part to reach that special relationship between the consistency of the medium and the consistency of the cell plasm which has been shown to exist for amoebae (Hogue 5).

While performing the previous experiments it became evident that the age of the amoeba had some effect on the rate of contraction of the vacuole. Here by age of the amoeba is meant not the age of one particular amoeba but the age of the whole cycle of growth on the Petri dish. Accordingly a series of experiments were performed to determine the relation between the age of the amoeba and the rate of the contraction of its vacuole. Media made up with 1.0 and 1.5 per cent agar were used in the different series of experiments, as these had proved the best densities for the cultivation and study of amoebae (Hogue 5). Two different kinds of *Limax* amoebae, A P_2 and A W, were used and the results compared.

The amoebae were grown on Petri dishes which were inoculated with a loop full of amoebae in the center of the dish. As the amoebae and the bacteria which served as their food multiplied, they spread out over the Petri dish in ever widening circles. The amoebae at the outer edge of the growth were always the largest and apparently in the most healthy condition. It was these which were used each day. The same method of observation as noted above was used. Five readings from five different amoebae were made and the averages calculated.

The temperature varied from 22° to 25.5° C. as the experiments were performed in July and August at Woods Hole. The Petri dishes were kept at room temperature which is not constant. However the slight variations did not seem to appreciably affect the experiments.

In tables II and III there is considerable variation but one notices a steady slowing down of the rate of contraction of the vacuole as the age of the amoeba culture increases. This is especially noticeable in table III where observations were made until the day the amoebae encysted.

Looking at the contractile vacuole as an excretory organ, as the culture ages, waste products accumulate in the medium, the metabolic processes are slower and the contractile vacuole does not pulsate so rapidly.

The difference in the vitality of the amoebae used can be observed in table III where A W encysted on the ninth day while A P_2, growing on the same kind of medium, under the same climatic conditions, did not encyst until the fourteenth day. It is of course possible that aside from the individual peculiarities of the amoebae there may have been great differences in the condition of the bacteria which surrounded them and served as their food.

It was also noticed that when an amoeba is at rest the rate of contraction of the vacuole is much slower than when the amoeba is moving. One amoeba was watched, which when it was quiet had a contractile vacuole pulsating at the following intervals in seconds: 70, 145, 105, 95. When it began to move, the rate of contraction immediately changed to every 60 and then every 50 seconds. This seems further evidence that the contractile vacuole functions also as an excretory organ. The faster the amoeba moves, the faster are the waste products formed and in order to expell them the contractile vacuole pulsates more rapidly.

TABLE II

1 per cent agar.

Age in Days	2	3	4	5	6	7	8	9	10	11	12	13	14	15
AP_2	39.6	42	39.5	53.2	50	49.6	46.6	46.2	58	55	58.6	58	51.6	44.4
AW	40.6	48.2	46.2	50.6	37.4	54	41.5	44.2	55.3	50.2	42.4	46	54	57.8

TABLE III

1.5 per cent agar.

Age in Days	2	3	4	5	6	7	8	9	10	11	12	13	14	
AP_2	27.4	47.2	54.8	42.2	46.2	49.5	37.8	50.4	52.2	53.2	53.8	55.5	Cysts	
AW	30	39	30.8	34.6	39.8	45.8	55.2	Cysts						

SUMMARY

1. Salt water amoebae were kept on a medium made up with fresh water for six days.

2. On this fresh water medium they developed 1, 2, 3, and 4 contractile vacuoles.

3. The rate of contraction of the vacuole in fresh water amoebae was more rapid when they were grown on 2.5 per cent agar medium, than when they were grown on 0.5 per cent agar medium.

4. The older the culture of the amoebae the slower was the rate of contraction of the vacuoles.

5. The more active the amoeba is the more rapid is the pulsation of its vacuole.

6. The rate of contraction of the vacuole varies in the different strains of amoebae used.

NORTH CAROLINA COLLEGE FOR WOMEN,
GREENSBORO, N. C.

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VARIATION OF PROTEIN CONTENT OF CORN

Paper II[1]

By H. B. Arbuckle and O. J. Thies, Jr.

Findings in Paper I

1. A rapid Kjeldahl method for the determination of nitrogen in corn.
2. Report of analyses of certain varieties chosen for experiment.
3. Corn grown in North Carolina, from West Virginia seed, showed lower protein.

Introduction

The protein content of corn determines its value as a feed. Increase of 1% enhances its value approximately ten cents a bushel. Corn is now purchased at so much per bushel. We pay the same price for corn containing 10% protein as we do for a corn containing 8%, whereas the former is worty twenty cents more as a feed. Coal is now purchased on the basis of its caloric value. Why should not the price of corn be determined by its food value?

It has long been known that the protein content of corn varies. What factors control this variation? This is the goal of this investigation undertaken in 1920.

The first paper was read before this Academy at its spring meeting, 1922. This paper presents the results of further investigation with particular reference to climate.

Comments on Findings in Paper I

Analysts may be interested to know the result of the more careful examination of the Kjeldahl modification employed in previous years.

For convenience, a brief summary of the method is given.

A three gram sample of corn, finely ground, is introduced into a Kjeldahl flask, 0.3 gram of copper sulphate, C. P. added, and 25 cc. sulphuric acid with phosphorus pentoxide. After digesting till the material in the flask is well liquefied, which requires from seven to ten

[1] For paper I see this Journal **38**: 84. 1922.

minutes, ten grams of potassium sulphate, C. P. is added. Digestion is continued five minutes after clearing. Time required for digestion, twenty-six to forty minutes.

In view of statements made in standard books,[2] that in cereal analysis digestion for four hours is recommended, the longer digestion was employed in a number of experiments.

In analysis F′, given below, the usual method, five minutes digestion after clearing, was employed. The average per cent of nitrogen is 1.532%. In analysis F″, the digestion was continued three hours after clearing. The result was almost identical with the mean of F′. Again, in analysis G, the mean is 1.572% nitrogen. G′, digested three hours after clearing, gave 1.587% of nitrogen, an increase of only 0.01% nitrogen. This confirms our former statement that 26 to 40 minutes will suffice to give complete results on nitrogen.

A method involving so many operations as the Kjeldahl, must give occasion for errors in analysis, yet the variation observed in some of the analyses reported below, seemed too great. Analysis B shows a range of 0.037% of nitrogen, equivalent to 0.23% protein. In E there is a range of 0.032% of nitrogen, and in one set of analyses not included in this paper, the variation amounted to 0.05% of nitrogen. Our blanks also showed a similar puzzling variation. These results, with the blank suggested as the cause of the irregularity, the one factor not constant, namely, the quantity of alkali employed to neutralize the acid in the Kjeldahls. On investigation it was discovered that even C. P. sodium hydroxide contained appreciable amounts of ammonia. Since we used more alkali in neutralizing the acid in the blanks than in neutralizing the acid in the corn samples, the correction factor would be too large. Furthermore, as no effort was made to take the same amount of alkali in the blanks, the results could not be expected to agree. In the later analyses, this was tested by using a constant quantity of 50% alkali in all experiments. Our blanks were much closer, and there was less variation in the per cent of nitrogen in the corn analyses. Note the close results in A′. For accurate work, the analyst should employ equal quantities of alkali both in the blank and in the samples to be determined.

The "White Plume" analysis reported in paper I, was made from a different sample from that actually planted. A sample of the corn

[2] Technical Methods of Analysis: Griffin, page 65.

used in our experiment analyzed 8.41% of protein. Likewise, the Silver King corn planted in West Virginia and in North Carolina in 1922 showed a different analysis from that reported in paper I. The corn used contained 9.07% of protein. More careful analysis of the low protein corn planted in West Virginia gave 6.82% of protein.

Our investigation in 1922 showed that the Silver King corn grown in West Virginia, that analyzed 8.5% protein, when grown in North Carolina, gave only 7.7% protein. Since our analysis of this corn, we learned that it was planted late in the season, and was probably not well matured. The ears were small, and the grains shriveled. We are compelled to withhold any conclusions as to the effect of climate on this reduction of protein, since the analysis of immature corn shown in the tables, indicates a decided diminution in nitrogen.

RESULTS OF FURTHER INVESTIGATION OF THE VARIATION OF PROTEIN

We have continued our investigation of variation in protein of corn, by making analyses of the Silver King variety grown in West Virginia and in North Carolina in 1922. The seed was grown in West Virginia in 1921. The results are reported below under C, D and F′. This corn was planted in two places in North Carolina, on soil quite similar. Since the locations chosen were only 20 miles apart, the climate was practically the same. The seed corn planted contained 9.07% protein. The sample grown in West Virginia showed 8.68%. One sample grown in North Carolina contained 9.57%, the other, 9.62% protein. The two corns grown in North Carolina show very nearly the same amounts of protein. Each had increased by 0.6% protein. We also made analyses of the White Plume corn, seed grown in 1921 in North Carolina containing 8.41% protein. This corn was planted in North Carolina and in West Virginia. The analyses are given below under A′ and B. The corn grown in North Carolina in 1922 contained only 7.75% of protein, a decrease of 0.66%. The sample grown in West Virginia contained 8.37%,—scarcely any change in protein.

The yellow corn, Golden Dent, low protein corn, contained 6.82% of protein. This seed was grown in North Carolina in 1921. The sample grown in West Virginia in 1922 contains 8.22%, an increase of 1.40% of protein.

Analysis of Additional Varieties

We have given the analyses of additional varieties which we shall include in our investigations.

Blanchard's White is a prolific corn, rich in protein, and White Cap is a yellow corn, also rich in protein. The former will be planted both in North Carolina and West Virginia with seed grown in North Carolina. The latter will be grown in both states from seed produced in West Virginia.

Investigation of Immature Corn

We give the analyses of immature corn of two varieties under I and J. Both show a diminution in protein. It is very evident that this presents another very serious difficulty, making it necessary to select in the field the ears that compose the sample in order to avoid getting ears not fully matured.

Taking of the Samples

The samples taken for analyses were made up of grains taken from at least twelve representative ears. These grains were ground and thoroughly mixed.

The analysis of single ears chosen from three of the varieties studied would indicate considerable variation in protein in ears of the same variety amounting to as much as 0.5%. Possibly the breeding factor enters here to complicate our problem, and points to the necessity of taking larger samples.

Tables Giving Results of Analyses, 1923

All analyses made with three gram samples.

Corn A, White Plume, grown near Davidson, N. C., 1922.

	Nitrogen	*Protein*
No. 1.	1.236%	
No. 2.	1.244%	
Mean	1.240%	7.75%

Corn B, White Plume, seed grown in North Carolina in 1921, the sample analyzed grown in West Virginia in 1922.

	Nitrogen	*Protein*
No. 1.	1.334%	
No. 2.	1.362%	
No. 3.	1.325%	
Mean	1.340%	8.37%

Corn C, Silver King. This is white corn grown in West Virginia in 1922.

	Nitrogen	*Protein*
No. 1.	1.396%	
No. 2.	1.357%	
No. 3.	1.410%	
Mean	1.388%	8.68%

Corn D, Silver King. Seed of this corn was grown in West Virginia in 1921, and the corn grown in North Carolina, near Charlotte, in 1922.

	Nitrogen	*Protein*
No. 1.	1.547%	
No. 2.	1.532%	
No. 3.	1.532%	
Mean	1.537%	9.62%

Corn E, Golden Dent. The seed of this yellow corn was grown in North Carolina in 1921, and the sample analyzed was grown in West Virginia in 1922.

	Nitrogen	*Protein*
No. 1.	1.322%	
No. 2.	1.296%	
No. 3.	1.328%	
Mean	1.315%	8.22%

Corn F, Silver King. Seed of this sample grown in West Virginia in 1921, sample grown in North Carolina near Davidson in 1922.

	Nitrogen	*Protein*
No. 1.	1.545%	
No. 2.	1.532%	
No. 3.	1.586%	
Mean	(See F″, below).	

Corn F″, Silver King. This corn is the same as F, and the analysis the same, except that the digestion was continued for three hours after clearing.

	Nitrogen	*Protein*
No. 1.	1.516%	
No. 2.	1.483%	
Mean	(Of F and F″) 1.532%	9.57%

Corn G, White Cap. This is a West Virginia corn, grown in West Virginia in 1922.

	Nitrogen	*Protein*
No. 1.	1.556%	
No. 2.	1.569%	
Mean	(See G′, below).	

Corn G′, White Cap. This corn same as G, and analysis same, except that the digestion was continued for three hours after the acid had cleared.

	Nitrogen	*Protein*
No. 1.	1.599%	
No. 2.	1.575%	
Mean	(Of G and G′) 1.572%	9.84%

Corn H, Blanchard Prolific. The seed of this sample was grown in North Carolina in 1921, and the sample grown in North Carolina in 1922.

	Nitrogen	*Protein*
No. 1.	1.492%	
No. 2.	1.501%	
Mean	1.497%	9.36%

Corn I, White Plume. The seed of this corn was grown in North Carolina in 1921, and planted in West Virginia in 1922, same as B, but this sample, I, did not mature.

	Nitrogen	*Protein*
No. 1.	1.229%	
No. 2.	1.225%	
No. 3.	1.258%	
Mean	1.237%	8.29%

Corn J, White Plume. The seed of this corn was grown in North Carolina in 1921, sample grown in North Carolina in 1922, same as A, but this sample, (A) did not mature.

	Nitrogen	*Protein*
No. 1.	0.983%	
No. 2.	0.995%	
No. 3.	1.011%	
Mean	0.996%	6.22%

Future Plans

It is our purpose to extend this investigation for a number of years, seeking to eliminate the errors that may vitiate our results. We shall study a larger number of varieties, and use extreme care to preserve the integrity of each.

We shall preserve samples of all the corns analyzed, and, to simplify reporting, will employ the same notation each year. A will represent White Plume grown in North Carolina; A′ a special analysis of the same sample, of the same corn selected in a different way, and A″ an analysis of a different sample of the same corn. B will represent White Plume grown in West Virginia, seed from North Carolina. Each corn year after year will be represented by the same letter.

Next year we shall extend our investigation to include fertilizers and climatic changes, later we shall investigate soils.

At present we shall report only the facts, and withhold any conclusions until we come into possession of more accurate information.

SUMMARY

1. Brief discussion of facts presented in former paper.
2. Influence of long digestion of the Kjeldahl after clearing. Errors arising from using varying amounts of alkali in neutralizing Kjeldahls.
3. Report of analyses of corn grown in North Carolina and West Virginia.
4. Report of analyses of additional varieties for further experimentation.
5. Analyses of immature corns.
6. Method of notation to be employed.

DAVIDSON COLLEGE, N. C.

DENSITY OF THE CELL SAP OF PLANTS IN RELATION TO ENVIRONMENTAL CONDITIONS

By C. F. Korstian

Every observer of plant life in the mountainous regions of the West is familiar with the altitudinal zonation of the different types of vegetation ranging from the characteristic xerophytic greasewood-shadscale and sagebrush deserts or grasslands at the base of the mountains to the mesophytic spruce-fir forests common on the summits. The causes of this zonation have been investigated by ecologists by analysis of the component factors of the environment. One of these factors which was studied recently by the writer in Utah—the density of the cell sap of plants in relation to environmental conditions—has thrown considerable light on this rather complex problem of plant succession. Although the detailed results might not be of sufficient interest to warrant presenting them before this Academy, yet the general principles are of such a broad scope as to suggest the existence of a somewhat similar though possibly very much less pronounced relation in North Carolina. It will be impossible, in the time available, to more than touch upon the salient features. A more detailed report will appear at a later date.

Among the relations which plants bear to their environments, those of water are of the first importance. None of the environmental factors is of more significance than the forces with which the soil withholds and the air withdraws water from the plant. The passage of water through the organism, however, is not a simple process. It is complicated by the presence of substances in solution, and this involves osmosis, or the movement of the solvent through the cell wall membranes from the weaker to the stronger solution.

The laws of osmosis set forth explicitly that a substance in solution tends to distribute itself uniformly throughout the entire volume of the solvent. In the plant cell no absorption will take place when the concentration of the solution outside is equal to that within the cell vacuole, and if the outside solution is the more highly concentrated water will actually be withdrawn from the vacuole, which will be-

come smaller. An osmotic interchange through the cell walls thus accompanies and complicates the simple movement of water, and though millions of cells may intervene there exists a direct osmotic relation between the topmost leaf of the tallest tree and the soil solution at its root tips.

Although a consideration of the physico-chemical laws of diffusion and osmosis are prerequisite to a thorough understanding of the water relations of plants, especially absorption, diffusion and osmotic pressure, yet this hasty resumé must suffice for the purposes of this paper. Many investigations have been conducted to determine the influence upon the organism of the medium in which it is grown, but it is only recently that osmotic pressure has been studied in this connection. Among such researches those of Drabble and Drabble, Fitting, Dixon and Atkins, Harris, Gortner and Lawrence should be mentioned.

A consideration of the factors surrounding the problem and the results which were to be attempted indicated that the study of osmotic concentration in relation to environment should be so conducted as to present as great a diversity of habitats as possible. If, as was anticipated, differences in the densities of the sap were correlated with the habitat, the relationship would be sufficiently pronounced to be evident at once. An investigation of the properties of the intracellular fluids of forest vegetation on various habitats, in which the supply of available soil moisture and the evaporating power of the air varied greatly, would throw considerable light upon the basic physiological problems of silviculture and forest distribution. Chief among these may be mentioned the relative ability of different species to extract water from the soil and retard transpiration through increased sap concentration, the relation of sap density to frost resistance, and the role of the osmotic pressure of the cell sap in the adaptation of exotic species.

Six series of osmotic concentration tests were made at different times and places in the Wasatch Mountains of Utah. These covered a wide range of habitats (in all about 800 tests) extending from the typically arid alkali flats occupied by greasewood (*Sarcobatus vermiculatus*) and shadscale (*Atriplex* sp.) at elevations of 4,500 to 5,500 feet, through the sagebrush (*Artemisia tridentata*), pinon-juniper (*Pinus edulis-Juniperus utahensis*), oakbrush (*Quercus utahensis*), and aspen-fir (*Populus tremuloides-Pseudotsuga taxifolia*) associations to the spruce-fir (*Picea engelmanni-Abies lasiocarpa*)

association at an elevation of 10,000 feet or more. The samples of leaf tissue were collected in air-tight test tubes, then frozen, and the sap expressed in a specially designed press. The sap density determinations were made by means of the standard method proposed by Dixon and Atkins and further developed by Harris, Gortner and Lawrence, whereby the osmotic pressure of the sap is calculated from the observed depression of the freezing point. The freezing point depressions were determined by the well-known Beckmann thermometric method. The Beckmann thermometer was read to thousandths of degrees and the results were then expressed in freezing point lowering in degrees C. (Δ) and in atmospheres of osmotic pressure (P), after corrections for undercooling were made by using the formula suggested by Harris and Gortner as follows:

$\Delta = \Delta' - 0.0125\ u\ \Delta'$, in which $\Delta =$ the true depression of the freezing point, Δ' the observed depression of the freezing point $u =$ the amount of undercooling in degrees C., and a constant (0.0125) experimentally determined, according to the tables calculated by Harris and Gortner.

Interesting and fundamental relationships are brought out when some of the easily measured environmental factors—especially precipitation, the march of the available soil moisture and the evaporating power of the air—are correlated with sap density. Since the ability of the plant to maintain a proper balance between absorption and transpiration is of vital importance, even at the intermediate elevations of the mesophytic aspen-fir type and increasingly so toward lower altitudes and xerophytic habitats, any practicable means which can be found to determine the water relations within the plant and between the plant and its environment will be of decided value. The correlation between habitat and sap concentration which was found in this study affords such a means. It may well be illustrated here by one of the series of tests, which was made on and adjacent to the Wasatch Plateau, near Ephraim, Utah, in July, 1921. The average densities of the cell sap of all species on the several vegetative associations studied were as follows, the associations arranged progressively from low to high altitudes:

Association	Altitude	Depression of Freezing Point	Osmotic Pressure
	Feet	*Degrees C.*	*Atmospheres*
Greasewood-shadscale...	5,500	4.29	51.3
Sagebrush............	5,800	2.35	28.2
Pinon-juniper.........	6,000— 7,500	1.78	21.4
Oakbrush.............	6,500— 8,500		
Southern aspect.....		1.66	20.0
Northern aspect.....		1.36	16.4
Average............		1.47	17.7
Aspen-fir.............	8,000— 9,500	1.25	15.0
Spruce-fir.............	9,500—10,700		
Southern aspect.....		1.25	15.0
Northern aspect.....		1.05	12.6
Average............		1.16	14.0

The close correlation between altitude and sap density within the different associations is very apparent. Similarly, the concentration of the sap for individual species decreases with an increase in altitude. This may be readily illustrated by the common sagebrush (*Artemisia tridentata*) which was found to cover an extreme altitudinal range of over 5,000 feet. In the sagebrush association at an elevation of 5,800 feet the sap of this species had an osmotic pressure of 35.2 atmospheres which decreased with an increase in altitude until in the spruce-fir association at an elevation of 10,700 feet the osmotic pressure was only 14.5 atmospheres. Other species exhibited similar tendencies. The sap densities of the different species showed variations corresponding to the xerophytism of the associations in which the species were growing, especially when the determinations were made at or near the critically dry part of the growing season. It is evident, therefore, that (1) the water relations of the plant have a vital bearing on the succession of plant associations and (2) the causes of these phenomena are associated with the osmotic properties of the plant juices and the soil solution. The common progressive succession is from the high osmotic pressures in drought-resistant species of the xerophytic habitats of the lower mountains, through the mesophytic associations composed of species having successively lower sap concentrations, to the climax spruce-fir association of uniformly low osmotic pressures.

A close correlation of plant succession with the underlying causal factors shows that the succession is from xerophytism and drought-resistant species toward greater mesophytism and species of lesser drought resistance as the atmospheric and soil moisture increases and produces greater stability and lower sap densities. It is evident that the existence of a high osmotic concentration of the soil solution tending toward a physiological dryness of the soil would prove most detrimental to species of low sap concentration by cutting off the moisture supply. Shallow-rooted species having low sap concentrations would be the first to be adversely affected by periodic droughts. The depth of penetration, lateral spread, general character of the root system and volume of soil penetrated by the roots, as well as the capacity of the species to absorb moisture, are all important in determining the adaptability of the species to a given habitat. Likewise, these factors influence the amount of moisture available to the plant.

The zonation of plant associations and their alternation on opposing north and south aspects can be logically explained on the basis of the effect of environmental conditions on the known physical properties of the cell sap of their component species, although occasionally other factors may cause more or less sporadic occurrences. Such cases of distribution can be traced often to those factors which offset undesirable environmental conditions during the seedling and sapling stages, such as shade or other means of protection.

These studies indicate that osmotic pressure also influences growth, which is accelerated by weak soil solutions and retarded by concentrated ones. Both age and the conditions of growth influence the osmotic pressure of the cell sap. Newly developed leaves showed lower concentrations in midsummer than one year old leaves taken from the same plants, all of which were growing in the same habitat under identical exposure.

In the course of a year the plant passes through a definite cycle of changes directly dependent upon the moisture content of the soil and atmospheric conditions which may materially influence sap concentrations. In the spring the concentration is uniformly low. With the advance of the season and the advent of midsummer the supply of available soil moisture is usually very much depleted and transpiration has been materially increased by the occurrence of the highest temperatures of the season and the greatest sunlight intensities. All of these factors, together with a minimum of precipitation, unite to cause a

critical period for the plant with the result that it is then that the maximum sap densities of the growing season occur.

Determinations made in the middle of the winter, on the other hand, showed the conifers to have low concentrations, while the closely associated evergreen shrubs exhibited high concentrations. Furthermore, the sap densities of the shrubs increased with an increase in elevation—a complete reversal of the results obtained during the growing season. Inasmuch as the winter densities were so completely at variance with those of the growing season a special micro-chemical study was made to determine the underlying causes. The writer was led to conclude that with the advent of cold weather in the autumn and early winter, a large part of the starch in the conifers is converted into oil or fatty substances which are osmotically inactive and form emulsions having low osmotic concentrations. In the evergreen shrubs, which showed little or no oil present, the starch was evidently converted into soluble sugars, thereby materially increasing the osmotic concentration of the cell sap.

In summarizing, it may be said that these studies showed that the osmotic concentration of the cell sap of plants may be used as an index of habitat in correlating the great complex of habitat factors with the physiological responses of the plant. The density of the sap of a species, however, is not constant. It may be influenced by any of the environmental conditions affecting transpiration, the products of photosynthesis or the supply of available soil moisture. Osmotic pressure in plants is more rapidly changed by fluctuations in the moisture conditions of the habitat than by temperature or light. During the growing season the lowest sap concentrations occur in those mesophytic plant associations which are successionally the most highly developed with reference to an adequate supply of available moisture and in which the complex of conditions is most favorable to plant growth. On the other hand, the highest densities occur on the most adverse sites, either the driest or the most saline.

In North Carolina, although a maximum altitudinal range of 6,700 feet is encountered in passing from the eastern coastal plain swamps and pine lands to the spruce-fir forests on the higher mountains of the western end of the state, the extreme concentrations noted

above should not be expected, chiefly because of the fact that the entire state lies in a humid region. However, notwithstanding the warning of the sages that speculation is dangerous, even here the writer would expect to find notable differences between typical habitats, as, for example, between the hot pine lands and the cool spruce-fir forests which are often enveloped in dense fog. Likewise, at intermediate elevations in the mountains rather striking contrasts should also be expected between the sap densities of species indigenous to the dry slopes and ridges and those of the moist slopes and coves.

ASHEVILLE, N. C.

THE RESEARCH PROGRAM OF THE APPALACHIAN FOREST EXPERIMENT STATION

By E. H. Frothingham

Among papers devoted almost wholly to explicit results of research, such as appear on the program of this meeting, one like the present, which is merely an announcement of research in progress or planned, might appear somewhat out of place. Yet the accession of any new investigative organization ought to be of interest to scientists in all fields. The work of the Appalachian Forest Experiment Station will touch at so many points the investigations of various members of this Academy that a knowledge of the purpose and outlook of the new station should be of mutual benefit. Very little can be conveyed in a short discussion. The aim of this paper is therefore merely to sketch the high points of the work of the station and its background of forest research, with the hope of establishing a helpful contact with the members of the Academy.

Although forest research has long held a recognized and established position in Europe, it is still young in this country. It was only fifteen years ago that the hopelessness of attempting forest raising in America without well established principles, based upon American conditions, caused the establishment by the U. S. Forest Service of its first forest experiment station. Six of these are now in existence in widely separated parts of the country and, as evidence of the growing recognition of such institutions, two more are to be installed in July. The stations are so located, with respect to the principal forest regions, that each has before it a distinct group of vegetational and environmental conditions, usually very different from those of the other stations. Yet there is a similarity in the problems encountered which allows of a general classification.

The Appalachian Forest Experiment Station was established in 1921, with headquarters at Asheville, North Carolina. It has perhaps the most varied and complicated field for investigation of any of the forest experiment stations. Its territory extends south from Pennsylvania to northern Georgia and Alabama, and embraces from east

to west, six major topographic units: the Coastal Plain, the Piedmont Plateau, the Southern Appalachian Mountains, the Appalachian Valley, and the Cumberland and Alleghany highlands. This region of about 185,000 square miles is bigger than the combined area of Pennsylvania, Delaware, New Jersey, New York, and New England. With a range of 6,700 feet in altitude and 6 degrees of latitude, and a correspondingly great climatic variation, there is an extreme diversity of forest types and vegetation in general. The pine flats and overflow lands of the Coastal Plain present problems very different from those of the subalpine spruce forests of western North Carolina. Between these two extremes there lies the whole of the great Appalachian hardwood region with its multiplicity of forest types and conditions. The administrative difficulty of carrying on studies efficiently in this great region, and with a technical staff of only four members, has led to a policy of widespread coöperation and the concentration of the work as far as possible at definite regional centers.

Before entering upon a discussion of the work of the station a few words may be in order as to the general nature and object of forest research.

Forestry, being a use of land to produce timber crops, is a branch of agriculture. Like agriculture, it is an art and a science, resting upon other sciences—biology, geology, physics, chemistry, and mathematics—for most of its basic data. As a special branch of agriculture, as yet new and little tried in this country, it makes unique demands upon scientific research. The essential differences between forestry and other uses of the soil consist chiefly in the long time needed to mature forests as compared with other crops, the variety of products obtainable during the period in which the principal crop is maturing, as well as at the time of the harvest, and the possibility of improving the yield and reproducing the crop naturally by partial cuttings.

The best management of forest lands for timber and other incidental uses is predicated upon a thorough knowledge of a great variety of conditions and processes. It is difficult to place these in order of their relative importance because in different places each may be of major importance. As a basic groundwork an intimate knowledge of the life histories, characteristics, and requirements of the various tree species is necessary. This has special reference to their reproductive adaptations, soil and moisture requirements, rate of growth, endurance of shade, and susceptibility to injuries of vari-

ous sorts. The physical conditions, climatic and edaphic, which affect the rate of growth and the composition of the forest, must be determined. The characteristic ecological associations and societies (forest types) must be ascertained, and the causative factors identified. A knowledge of such matters as these is the foundation upon which true forest research ought to rest. Unfortunately this is still a scarcely touched field requiring protracted investigation, and in the meantime insistent demands must be met for information which can be used at once in forest management. This explains the fact that there are two phases of the more purely biological part of forest research now being carried on at the forest experiment stations, one having to do with the discovery and classification of facts and causes, the other with results based upon somewhat empirical assumptions or only partial y understood antecedents. Research of the latter class is warranted, first, by the great number of interacting factors and the long periods of time that will be involved in their analysis; and second, by the possibility of securing many reliable and directly useful results without an appeal to underlying causes. This is particularly true of work in forest measurements, planting, thinnings, and growth studies, and it is much less true of studies of the succession of forests after cutting.

The field of forest research at the Forest Service experiment stations is divided into seven comprehensive groups. At the Appalachian Station work is now being done under five of these, each represented by one or more of the twelve active projects. The program ahead of the station can be best described by taking up these seven groups one by one. They will be given in the order which nearest approaches the logical sequence of the development of research, although as previously stated, other considerations make it impossible or even undesirable to conform to this sequence in the chronological order of investigations.

Forest type studies. The unit in forest management is the stand, rather than the species. The classification of forest societies (types) and physical environments (sites) therefore forms the basis for all other investigative work. In the Southern Appalachians the large number of species and the variety of habitats make this a particularly difficult matter. Very few efforts have been made to secure a logical and practicable classification,* and the matter is now in the hands of

* A comprehensive classification has been offered by W. W. Ashe. See *Journal of the Elisha Mitchell Scientific Society* **37**: 183-198. 1922.

a committee of the Southern Appalachian section of the Society of American Foresters. A preliminary study of forest sites has been made by the Forest Service, and a scheme for measuring the qualities of sites by the height growth of dominant trees of certain Appalachian hardwood species has been devised.

Forest succession and the factors responsible for forest types are subjects of interest to both the ecologist and the forester. An understanding of them is essential to the best management of the forest and coöperation with ecologists in the study of these factors will be welcomed by the Appalachian Station.

Tree studies. The object of silviculture is to produce stands of rapid-growing and intrinsically valuable species. This requires knowledge of the life habits, reproductive capacities, rate of growth, soil and moisture requirements, susceptibility to and protection from injuries, and other characteristics of a great number of tree species. The vast field thus presented for work at the station has barely been entered. Studies of yellow poplar (*Liriodendron tulipifera*) and southern white cedar (*Chamaecyparis thyoides*) are now being made.

Forest protection. Under this heading are included investigations of sources of damage to the forest, such as fire, insects, live stock, fungi, and weather. Fire is of course the most important source of loss, and two projects are now being undertaken, one to determine the nature and amount of damage under different conditions, the other to discover an effective means of forecasting periods of special fire hazard. Promising results in both studies are being secured. A study of the amount and importance of grazing damage in reproducing stands is also being made. Fungi and insects have not yet been dealt with, but coöperative work on these will undoubtedly form a part of the station's future activities.

Forest influences. The relation of forests and other vegetative cover to the run-off of streams, to erosion, to the climate of the region in which they are located, and the effect of forest cover and attendant organisms upon the physical condition of the soil are subjects upon which no work has yet been done by the station. Within a short time studies of the more practical phases will likely be called for, such as the effects of the removal of forest cover upon erosion and the silting up of reservoirs. The study of less immediately applicable phases will probably have to be postponed indefinitely.

Reforestration. In the Biltmore estate plantations at Biltmore, North Carolina, the Southern Appalachians possess what is probably the largest of the older forest plantations in the United States. Many different tree species, both native and introduced, were planted there from ten to thirty-five years ago, and the plantations now afford an invaluable field for experiment as well as a practical test of the species used. A study of the more important of these plantations is about finished. Records are also to be kept of other plantations in the region, and tests of a large number of native and exotic species are contemplated in different sites within the territory of the station. As a start, seedings and plantings of exotics have already been made in the spruce type in the Black Mountains of North Carolina, and elsewhere, in co-operation with the administrative branch of the Forest Service, the Champion Fibre Company, the State Forester of North Carolina, and others.

Forest Measurements. This is a very wide and necessary field of investigations which has already been entered by the station in connection with other projects. It embraces the study of the growth and yield of stands; the rate of growth in height, diameter and volume of individual species; and the form of trees with reference to their merchantable contents for the construction of volume tables. Data secured in such studies are essential to the preparation of forest management plans, and are necessary also in the other branches of the research work.

Forest management. This is one of the largest and most important fields of endeavor which the station has before it. In a sense it is the culmination of the other lines of research previously outlined, since it depends upon them for basic data and is the means by which much of the other investigative work will be made available for practical application.

The objects of forest management investigations are chiefly (1) to discover means of encouraging reproduction of desirable species; (2) to determine, for different forest types, the methods of cutting best fitted to secure natural reproduction in the shortest possible time; and (3) to work out by experiment the methods and frequency of thinnings which are best adapted to particular species and sites. There are other management problems but these are the most important and the most in need of solution. The management studies are relied

upon to furnish the data necessary to transform the generally culled, fire damaged, poorly stocked forests of the Southern Appalachians into a working stand of thrifty, actively producing second-growth.

The studies of natural reproduction and methods of cutting are especially dependent upon a knowledge of the physical and biological factors of the environment and of the characteristics and requirements of the various tree species. Until this knowledge is at hand, the investigation must be, to a greater or less extent, empirical. Two projects are now under way, one a study of natural reproduction on cut-over and burned lands in the spruce type, the other a study of reproduction in the hardwood types following different methods of cutting. Work on the latter study will be centered, for the present, upon permanent sample plots, which will be established on areas on which logging is in progress. In these plots different cutting methods will be practiced, and records will be kept of the progress of the succeeding reproduction by means of numerous small quadrats. Such experiments will involve repeated observations extended over a period of years. The results will not be wholly conclusive because of our ignorance at the present time of the relative significance of the several factors which will affect them. Some results of value are practically assured, however, and it is within the bounds of possibility that data secured meanwhile in the studies of species and of the environmental factors will furnish the means of correctly interpreting the sample plot results. In this, as in other lines of forest research, the assistance of ecologists and plant physiologists may be of the greatest benefit.

To carry out the program thus briefly outlined the Appalachian Station, with its small staff and its large field of operations, cannot depend entirely upon its own efforts. It must have the coöperation and the counsel of interested and progressive men in the sciences as well as in the industries which are represented in the region. To this end the station would like nothing better than to enlist the interest and, to the extent of its facilities, the active participation of those members of the Academy who are engaged in related lines of work.

ASHEVILLE, N. C.

CHEMICAL INDUSTRIES IN NORTH CAROLINA IN 1922

By Frank C. Vilbrandt

A sudden metamorphosis has occurred in North Carolina within the past decade, by which the state has moved from the twenty-third to the tenth place in value of its industries. Many factors have contributed to this development, no single condition being alone responsible. In this sudden development the chemical industries have maintained their balance, contributing as much to the progress as the two leading industries, cotton and tobacco, and more than the others. With the phenomenal development of the chemical industries during the past decade and the present outlook of the industries, 1930 should place North Carolina in the ranks of the leading chemical states of the Union. Agriculturally the state ranks fourth, due to its enormous acreage in cotton and tobacco; this position in agriculture to some extent regulates the state's chemical position inasmuch as the raising of such crops imposes a heavy demand upon the chemical industries for fertilizers, and the by-products yield a very productive source of raw materials for chemical treatment, viz., cotton-seed oil.

Compilation of data from the reports of the Department of Printing and Labor (1900-1922) show that the chemical industries are almost on a par with the tobacco industry, in which the state leads the world. In 1922 there were 361 operating chemical plants of more or less importance employing 11,338 people, who produced $206,640,000 worth of products on an estimated capital investment of $119,646,000. The 450 cotton mills throughout the state employed at the same time 73,600 people yielding $285,000,000 of products on a combined capital investment of $200,000,000. In 1910 there were but 162 chemical plants with a capitalization of $11,525,000, a plant valuation of $10,-200,000 and employed 5,853 men. Data for value of products at that time cannot be secured so a comparison of productivity must be omitted.

RATING OF MANUFACTORIES IN NORTH CAROLINA

Arranged to show (1) capital invested, (2) estimated valuation, (3) yearly production value, (4) number of employees, (5) yearly pay-roll, and (6) number of plants.

Industries	*Capital Invested*	*Estimated Plant Valuation*	*Annual Production Value*	*Number of Employees*	*Yearly Payroll*	*Number Plants*
Cotton Mills	$ 200,000,000	$ 185,775,000	$ 285,000,000	73,600	$66,240,000	450
Tobacco Plants	130,440,000	112,500,000	225,000,000	9,300	15,000,000	23
Chemical Industries	119,646,000	87,770,000	206,640,000	11,338	10,589,000	361
Fertilizers	79,750,000	39,700,000	31,920,000	1,895	1,950,000	57
Cottonseed Oil Products	12,000,000	28,000,000	133,600,000	2,350	1,665,000	56
Leather Tanning	8,300,000	6,500,000	10,650,000	1,300	1,300,000	16
Paper and Pulp	6,850,000	4,200,000	6,650,000	1,400	1,380,000	2
Ice	2,750,000	2,000,000	2,500,000	1,000	610,000	55
Drugs	1,086,000	2,500,000	6,390,000	656	710,000	29
Rubber	2,200,000	2,000,000	4,500,000	525	500,000	3
Ceramics	2,000,000	1,500,000	7,000,000	1,040	1,410,000	103
Gas and By-Products	2,500,000	500,000	1,500,000	250	350,000	10
Ores	1,260,000	550,000	1,250,000	593	500,000	17
Dyeing and Mercerizing	900,000	250,000	570,000	267	170,000	3
Wood Distillation, Rosin and Turpentine	50,000	70,000	110,000	62	44,000	10
Textile and Knitting Mills	31,150,000	22,500,000	33,000,000	16,500	1,237,000	175
Furniture Factories	16,000,000	15,000,000	40,106,000	14,000	8,500,000	124
Woolen Mills	2,800,000	2,200,000	3,400,000	951	841,000	9
Silk Mills	2,006,000	1,500,000	1,800,000	874	725,000	3
Cordage Mills	55,000	45,000	300,000	42	40,000	2
Others (Lumber Dealers, Garages, Flour Mills, Stores and Shops)	455,000,000	72,760,000	47,247,250	60,000	48,655,000	5,270

The data for the chemical industries lacks the data for water-purification plants, metallurgical plants and the gigantic plant of the Aluminum Company of America, located at Badin, which have not been reported for publication for some time.

Fertilizers. The entire fertilizer manufacturing industry of North Carolina entails an investment of approximately $79,750,000, an estimated plant valuation of $39,700,000 and a yearly production value of 31,920,000. Eighteen hundred ninety-five men are employed on an annual payroll of $1,950,000. The state ranks second in the Union in this important industry, outranked by Georgia alone.

The industry was started by the Navasso Guano Company at Wilmington and Selma in 1869, the next operations locating in 1890 at New Bern where two more fertilizer plants were erected by the same company. Then followed an expansion and extension of the industry throughout the state as follows: in 1900 there were fifteen plants; in 1910, twelve; in 1918, twenty-seven; while an increase to fifty-seven resulted by the end of 1922. The industry is divided up into the fish-scrap industry, located around Beaufort and Wilmington, the superphosphate industry located in the cotton and tobacco belt and the mixed fertilizer plants scattered throughout the state. The largest single corporation in the fertilizer business in North Carolina is the Virginia-Carolina Chemical Company, which established in 1893 nine plants with an investment of capital valued at $48,000,000. These plants are located at Charlotte, Durham, New Bern, Raleigh, Salisbury, Wadesboro, Wilmington, Washington and Winston-Salem.

Cotton Seed Products. The by-products from cotton-milling have given to the state an enormous industry. There are at present fifty-six plants engaged in producing and refining cotton seed oil, entailing an investment of over $12,000,000, a plant valuation of $28,000,000, a yearly output of $133,600,000, with 2,350 employees drawing salaries aggregating $1,665,000 a year. With an investment of but one-thirty-second that of its parent, the cotton industries, the cotton seed industry yields more than one-half in value of products.

The first cotton seed products plants were incorporated in 1898 by the Southern Oil Company at Wadesboro and Gastonia, and by the New Bern Cotton Oil Company at New Bern. The progress of the industry is indicated by the following growth in plant development:

in 1900 there were four such plants; in 1910, twenty-two; in 1918, forty; and in 1922, fifty-six.

The largest single corporation controlling a large number of plants is the Southern Cotton Oil Company with fifteen plants scattered throughout the Tidewater and Piedmont regions. The only company making the refined cooking products is the Swift Company located at Charlotte.

Leather and Tanning. The third chemical industry in rank is the leather and tanning industry. A capital investment of $8,300,000 yields $10,650,000 worth of tanned leather and tanning extracts. In 1922, twelve plants were tanning hides and producing extracts in addition to tanning, while four plants made tanning extracts solely. Four of the above plants have a capital investment or annual production value in excess of $1,000,000. The first company was incorporated in 1891 at Morganton, and in 1900 there were only four such plants in existence. The development since 1910 has not been in number of plants, but in the expansion of plants built in that time. An eight-fold expansion has been made along this line. The tanning industry is centered near the National Forest Reserves, especially near the Pisgah Forest Reserve in Transylvania County.

Paper and Pulp. Only one plant, located at Roanoke Rapids, manufactures finished paper. The capital investment of this plant is $850,000 with a plant valued at $200,000 producing $650,000 worth of finished paper with but 200 employees. The wood pulp plant incorporated in 1906 is situated near Canton, in Haywood County. It is capitalized at $6,000,000 and possesses an additional investment of $4,000,000 in plant and equipment. Over 1,200 people are employed at a yearly payroll of $1,250,000 with the consumption of 18,000 horsepower of electricity and steam in the production of $6,000.000 in finished products. Beside the manufacture of wood pulp, jute board and tannic acid, this plant is at present working on a large contract for the United States Government in the production of post-cards for the Postal Department.

Manufactured Ice. In thirty years the status of the ice industry has changed from that of a novelty to that of a standard commodity. Between the years 1888 and 1900 seven ice plants started operation. In 1900 there were nine plants, in 1918 forty-one, while in 1922 there

were fifty-five in operation with a total capital stock of $2,750,000, plant valuation of $2,000,000 and annual value of products of $2,500,-000. Over a thousand men are employed in the process of making ice, receiving annually a limited payroll of $610,000, due to the seasonal production of the commodity.

Drugs. The position North Carolina holds in the manufacture of patent medicines and preparations is known internationally. Gowan's Cure and Vick's Salve are two of the best known. Into the state has poured $6,390,000 for such products, on a capital investment of $1,086,000 and a plant valuation of $2,500,000. Six hundred fifty employees received $710,000 aggregate salaries during the last year. The Vick's Corporation, located in Greensboro, produces over $4,000,-000 worth of products per year.

Rubber. The oldest rubber plant in the state is only five years old while two others are but two years old, and a fourth has just begun operation. Yet their age does not bespeak their importance. A capital investment of $2,200,000 and plant valuation of $2,000,000 have produced $4,500,000 worth of products in the last year. In 1922 the infant industry employed 525 men and expended $500,000 in wages.

The largest plant is located at Charlotte, the McLaren Tire Company, but the other two, the Hanes Rubber Company at Winston-Salem and the Roula Manufacturing Company at Gastonia are not much smaller. The new plant of the Paul Rubber Company at Salisbury will greatly increase the industrial wealth of North Carolina when it begins running at capacity.

Ceramics. At present there are in existence one hundred and three ceramic plants, ninety-two of which make brick and tile, four make stoneware, two crockery and the other five make pottery in addition to crockery. Four of the brick yards make sewer and drain tile, clay roofing and terra cotta in addition to brick. A crockery plant making a very small output was started as early as 1867 in Monroe, Union County. However, the first large plant to be incorporated was the Pomona Terra Cotta Company of Pomona in 1865, which is now one of the largest in the state. The number of plants increased from five in 1890 to twelve in 1900, to twenty-five in 1910, to forty-seven in 1918 and to one hundred and three in 1920. The total amount of capital invested in ceramic plants in North Carolina is

close to $2,000,000; the plant valuation is $1,500,000 and their products are worth $7,000,000. One thousand forty workmen received $1,410,000 for wages in 1920 in this industry alone. The ceramic plants in the state are small, only eleven having an investment, plant valuation or production value of over $50,000 and thirty-six less than $5,000.

Coke, Gas, and Tar. The first gas plants incorporated in 1889 were the two Pintsch Gas Compressing Plants, located at Greensboro and Rocky Mount and still in operation. The other artificial gas plants are of recent origin, having been built since 1910. The latter are generally municipally owned and operated. The value of this industry to the state is shown by the fact that the sale of its products brings approximately $1,500,000 annually. The companies employ 250 men and have a combined yearly payroll of $350,000.

Ores. The ores mined in the state are talc, marl, iron ore, barytes and mica. These products are used in various industries both inside and outside the state. The value of mines and plants totals but $550,000, while the capital invested therein is over a million and a quarter dollars. There are eight active mines, twelve abandoned mines and seventy-two prospects and explorations from which ores can be obtained in the state.

Dyeing and Mercerizing. The dyeing and mercerizing industry involves a capital investment of $900,000, a plant valuation of $250,000, a yearly production value of $570,000 with 267 employees on a yearly payroll of $170,000.

The plants in operation in this state are subsidiary to the big cotton milling interests, the latter sending their products to be treated to these conveniently located chemical treatment plants. The larger individual treatment plants are located at Burlington, Mt. Holly and Tryon. In Durham, Hickory, Proximity, Revolution and Gastonia the big cotton and knitting mills have small bleaching and dyeing plants, but the financial data of these chemical treatment plants are included in the cotton industry reports.

Wood Distillation, Turpentine and Rosin. With the enormous pine forests there are but eight small firms engaged in one or another phase of the pine by-products business. The industry is concerned primarily with the production of turpentine and rosin. The plants

represent an invested capital of but $50,000 and an annual output of $110,000. Most of the plants are located in the southeastern part of the state, Brunswick and New Hanover counties being the center of the industry. Only 62 men were employed in this industry in 1922.

Hydroelectric Power. One of the governing influences in the further development of the chemical industries of North Carolina is the presence of the vast but limited water power. According to Saville (Hydraulic Engineer, N. C. Geological and Economic Survey) in 1922 over 360,000 horsepower have been developed at Bridgewater, Lookout Shoals, Blewitt Falls, Buckhorn Falls, Badin, Narrows of Yadkin, Cheoath, Tuxedo, Ivy, Marshall and Weaver. Eighty thousand horsepower or 22% is transmitted for use outside the state, and 113,000 or 31% used at Badin for the production of aluminum. The remaining 167,000 horsepower available for general, industrial and public use amounts to only 47% of the total developed in the state. Of this 45,000 horsepower is developed and used by private manufacturing establishments. At present the demands for power cannot be met, but much development work is contemplated in the near future.

On the basis of an output of 652,775,000 K.W.hr. in 1919, of an increase of 20% over this in 1922, and assuming a 10% increase per year, in 1925 there is estimated an output of 1,219,645,000 K.W.hr. and in 1930 of 1,964,250,000 K.W.hr. of electricity will be produced. To supply this on the basis of 93% produced by water power, the total installed horsepower required for 1925 will be 570,000 and for 1930, 919,000.

North Carolina has 2.07% of the minimum potential water power resources of the United States, and 8.9% of that east of the Mississippi, being exceeded in both cases by New York state alone. Several estimates of potential water power resources amounting to 1,000,000 horsepower have been made, with a maximum of 2,000,000 with storage. (p. 666, N. C. Labor Statistics, Water and Power Resources, 1920).

CHAPEL HILL, N. C.

DORMANCY IN THE SEEDS OF THE PERSIMMON

By H. L. Blomquist

In the autumn of 1920 when the writer first came to Trinity College, Dr. Bert Cunningham called his attention to the difficulty of germinating seeds of persimmon (*Diospyros virginiana*). This fact was observed while attempting to obtain root tips which in this plant are rather favorable for the study of mitosis. When seeds were placed under laboratory germinating conditions, occasionally a few would germinate while the majority persisted in remaining dormant. From these observations we concluded that here was another case of dormancy in seeds which has been shown by several investigators to be a rather common phenomenon among wild plants. Since some of the seeds would germinate occasionally, it seemed that it would be profitable to investigate the cause of the delay and the factors which bring about germination in nature.

In searching through the literature on the subject of dormancy in seeds, no reference was found dealing with the persimmon.

The seeds which were first used were gathered from the surface of the ground since the season was too far advanced to obtain seeds from the fruit. An attempt was made however to collect only those seeds which had come from the preceding summer's fruit. A number of these were put between moist filter paper in petri dishes and some in soil. Under both conditions the same results were obtained; a few seeds germinated while the majority, although plump and apparently healthy, remained dormant.

Simultaneously the morphology of the seed was studied. This was found to be covered with a single taniferous coat of medium thickness and a rather tough texture which adheres to the endosperm except in the micropylar end where it is underlain by another layer of cells which caps the radicle of the embryo and to which the outer coat does not adhere (fig. 1). Inside the testa is a thick horny endosperm

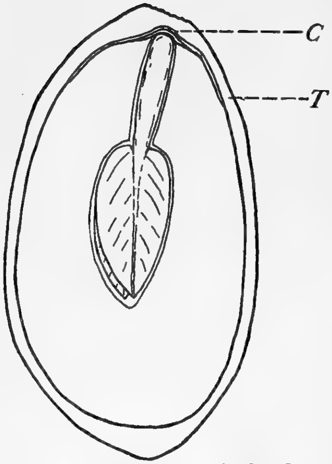

Fig. 1.—Median longitudonal section through the seed of persimmon showing testa, t, and cap, c.

composed of thick-walled hemicellulose cells. From the micropylar end of the endosperm a cylindrical cavity extends in which the embryo is located. This structure of the seed of persimmon resembles the structure of the seed of Iris which also shows dormancy and has been investigated by Crocker.[1]

In the autumn of 1921 some seeds were collected from mature fruits and were left to dry in the laboratory. As soon as these were thoroughly dried, which required about one week, some were put under germinating conditions intact while from others the testa and some of the endosperm were removed before placing them under similar conditions. After a few days some of the treated seeds showed signs of germination while among the untreated seeds no germination was obtained. This led to an examination of the treated seeds. It was found that in all the seeds where germination had become evident the cap which covers the radicle had been removed in the removal of the testa. After soaking a few seeds for two days the testa covering the micropylar end and the underlying cap were carefully removed, and after leaving these seeds under germinating conditions for three days all began to germinate while the intact seeds did not germinate at all. Several attempts have been made to germinate fresh seeds with testa intact but in all cases the results have been negative. However, among seeds which have been lying on the ground or in soil for a year or two, a low percentage of germination is usually obtained.

[1] Crocker, William, Rôle of seed coats in delayed germination, Bot. Gaz. **42**: 265-291. 1906.

Fig. 2.—Results obtained after three days under germinating conditions. A, seed intact; B, with outer coat of testa at the micropylar end removed; C, with outer coat and cap removed.

It is plainly evident that dormancy in the seed of persimmon is due to the structure of the seed coat and not to the embryo, and more specifically to the layer of the coat which overlies the radicle. But the question is, how does this layer bring about dormancy? Dr. Crocker states that in Iris this cap reduces water absorption by the embryo and this delays germination. In the case of the persimmon, the writer is convinced that while lack of water absorption plays a role in the delay of germination, the principal reason is the mechanical resistance offered by the seed coat to the extension of the radicle.

There is probably a third factor which is less obvious and more difficult to determine. It is evident that seeds which have been lying in the ground for a year or two germinate faster when the cap is removed than the seeds collected from fruits. The cause of this difference has not been determined yet, but it is probably due to enzyme production and the increase in power to absorb water. Tests were made for oxidases, peroxidases, and catalases and both fresh and old seeds seem to have an abundance of the last two, while oxidase was no more evident in the older than the fresher seeds.

How long the seeds lie dormant in their natural habitat has not been determined, but this probably depends upon several factors, such as, location of seed, kind of soil, water relation, weather conditions, and microscopical organisms in the soil. Germination seems to take place after the splitting of the testa at the micropylar end and the subsequent weakening of the underlying cap by exposure to the physical and chemical factors of air and soil and to fungal activity.

DURHAM, N. C.

NOTES ON THE TEACHING OF BIOLOGY

By H. L. Blomquist

There is no teacher of biology, I suppose, who has not often realized that, after all, the ideal way to study plants and animals is to search for them in their natural habitats. This is especially true of the introductory courses in which the natural histories are and should be emphasized more than the special phases of morphology and physiology. In the teaching of biology as in many other subjects of the curricula of our schools and colleges, the methods have swung from one extreme to another. No one will doubt for an instant that the laboratory of the early students of plant and animal life was mainly the wide out-of-doors, walled in only by the horizon or the limit of vision and roofed by the dome of the deep blue sky. But their aim was different from what it is today. They were primarily concerned with the external appearances, the mode of living and classification. As the studies evolved and differentiated, it was soon found that it was not always practical to follow this method. When one was satisfied to study only those organisms and their structure which were visible to the naked eye, or only slightly magnified, and the only equipment necessary was a magnifying glass, this method was possible.

Because of the tremendous development of the subjects of morphology and physiology and the subdivisions of these since the middle of the last century, it would be ridiculous to consider for a moment tha living organisms can always be studied where they are at home. Because of this morphological and physiological studies the laboratory has become a necessity. It met the need of a place for the housing of the necessary equipment and the affording of a place where this equipment could be most efficiently used.

But since the study of biology does not consist merely of acquiring training in the use of laboratory equipment and the knowledge c plants and animals is not confined to their minute structure and physiology, the laboratory method may be over-done. That the laboratory method has probably been over-done is evident from the fact that so many teachers of biology have too scanty a training in where

to look for material when they first venture out to teach. Many do not even recognize the material they want from the microscopical appearances in the natural habitats. Consequently a teacher of botany, zoology, or biology who is to be successful in his profession must revert back to the primitive methods and study his laboratory material where it occurs in nature. Those of us who have had the modern academic training in biology are often prone to look down upon the naturalist because he is not "scientific." It would be far better if we stopped to realize that the modern teacher of biology ought to be more of a naturalist than he usually is.

But not all teachers have the time, opportunity, and energy to take up nature study and collect the necessary laboratory material. What is the result? The biological supply house is resorted to. Material which could be secured in a few minutes' walk from the laboratory is ordered. This is usually preserved and therefore not in the most desirable condition. Some material must necessarily be studied in a preserved state, but in many instances the same material may be found near the institution in a living condition. Even if this is not in the desired stage it will be profitable to make a study of it in parallel with the preserved material of another stage. The desirability of using living material can not be over emphasized. It has been the experience of the writer both as a student and a teacher that unless the living material is used there is an element of mystery about it which hampers the proper comprehension of what is actually seen. While it is impractical in the elementary courses in biology to always use living material and to show the students where this occurs in nature, this should be done to the greatest extent possible.

Another unfortunate result of the over-doing of the laboratory method comes from the use of the microscope and microscopical preparations. To the beginner student in biology the compound microscope is more or less a mysterious instrument—he does not comprehend it. Consequently, I have heard instructors in biology, who are giving elementary courses, give voice to the contemplation of the elimination of microscopical study from elementary courses. Since this is not possible and the student must at sometime acquire a training in the use of the microscope, especially if he is to continue the study of biology, the next best thing to do is to eliminate as much of it as possible.

Probably the greatest danger from the use of the microscope comes from the use of prepared slides. There is perhaps nothing that confuses the mind of the student more than looking through a high power microscope at a prepared slide the making of which he has not the faintest conception. This is perhaps the most influential factor in creating the conception of "mysteries of plant and animal life." Now, since it is necessary that some things must be magnified to be seen and studied, it will be better to use the lowest magnification necessary. Very often better details of the image are obtained this way than by using higher magnification. If this is done, very often, a magnifying glass of from twelve to twenty-five diameters will give better results than a compound microscope.

Whenever possible the material to be studied should be put on the slide by the student, and when prepared slides must be used their study should be preceded by a careful explanation with the aid of models or drawings from what part of the organism the part or section came and how the section was cut. An explanation or demonstration of how temporary or permanent microscopical preparations are made will also be of great aid to the student in comprehending what he sees.

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THE COMMON NAMES OF SOME TREES

By W. W. Ashe

Such a wide difference has been noted between names used in botanical and forest literature for some of the most common trees of the southeastern states and the vernacular names, which are in use by the people, that it seems desirable to call attention to some of these differences and to ask other persons to record local names of their sections. It is not surprising that there is not absolute unanimity concerning common names. What is surprising is that so many vernacular names are of general application and that so many forms are definitely separated, and this is the more surprising when the perplexities of the botanists and foresters in their groupings and separations are considered. *Quercus shumardii* Buckl.[1] for example was not generally recognized scientifically until about the beginning of the present century. Yet the people of the lower Mississippi River valley as a rule distinguish it.

Quercus coccinea Muen., Spanish oak. The English name used in literature for this very distinct tree is scarlet oak, which is merely a translation of the Latin binomial. Michaux f. states (Hist. Arb. Amer., 1810-13) that not having noted a common name for this tree, the name *scarlet oak* which was given by his father would be a suitable one. The tree, however, was recognized and the name Spanish oak applied to it long before Michaux recognized it and proposed for its English name a translation of the scientific one. The distinctive characteristics of Spanish oak are its smooth pale gray bark; the spike or *pin* knots, the very defective character of the wood and deeply sinuate leaves. It is sometimes called spotted oak, particularly in Kentucky and Ohio.

As early as 1714 Lawson referred to it in his History of Carolina saying, "Spanish oak bears a whitish, smooth bark." Kalm in his Travels (Vol. 1, p. 66) mentions in New Jersey the black oak and then refers to "*Q. hispanica,* the Spanish oak, a variety of the pre- of *tinctoria.* According to Marshall it was known in New England in 1785 as Spanish oak.

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[1] For a discussion of this name see Bull. Charl. Mus. **14**: 9. 1918.

Q. palustris and *Q. coccinea* are alike in their coarse wood penetrated by many black knots, or pins. For this reason the name pin oak prevailingly applied to *palustris* is sometimes transferred to *coccinea*; and *palustris* is sometimes called (see Gray's Manual, etc.) swamp Spanish oak, as in southeastern Ohio.

Q. coccinea also resembles in its foliage and smooth bark *Q. shumardii* which, however, yields a superior timber free from pin knots. Where *shumardii* is common, as in the lower part of the Mississippi Valley, it is on account of its smooth gray, usually spotted or striped bark generally called spotted oak (or for the same reason leopard oak). Spotted oak is a name sometimes applied to *coccinea* in those sections where *shumardii* is not abundant.

In central Texas occurs *Quercus texana* Buckl. (Proc. Acad. Sci. Phil., 444, 1861, not *Q. texana* Sarg.), a small tree of limestone mountains with leaf and bark much like those of *Q. coccinea*, and it was interesting to find that the name Spanish oak has been transferred to it. It is in fact the Texas Spanish oak[2] and it seems should be so-called. The true Spanish oak does not occur west of the Mississippi River.

Another name which has caused confusion is pignut hickory. Michaux in 1810 used as a specific name for a hickory *porcina* which is translated into pig(nut) hickory. *Carya amara* similarly was translated into bitter (nut) hickory. Nuttall in 1918 gave prominence to these names in his Genera as well as in the edition of Michaux's Sylva with Nuttall's supplemental volumes. As Nuttall's scientific names were long in use the translations of these binomials acquired a certain standing in botanical and dendrological literature. They apparently do not conform, however, to vernacular usage.

C. amara Nutt. (*Hicoria cordiformis*) is the tree which is prevailingly known as pignut. *Carya porcina* (*H. glabra*), which on account of this transposition of common names has frequently been maligned in its descriptions as having bitter fruit, as well as yellow buds, is now

[2] Another tree closely related to the Texas Spanish oak is *Quercus stellapila* n. c. *Q. texana* var. Sarg., Bot. Gaz. **65**: 424. 1918. This is a small tree of the mountains of southwestern Texas and while related to *Quercus texana*, its fruit being somewhat similar, it is separated from all forms of *texana* by its pubescent twigs and foliage. The name of these trees in literature is Texas red oak. The only local name seems to be Spanish oak and this preferably should be their group designation.

separated into a number of species, at least three of which have distinctive common names as follows:[3]

Hicoria glabra, black or brown hickory or sometimes broom hickory, but of these black hickory seems to be widely known and very appropriate.

Hicoria pallida, sand hickory.

Hicoria ovalis (*microcarpa* or *odorata*), red (heart) hickory.

The history of the name pignut as applied in literature to *Hicoria glabra* has already been traced.[4] Doctor Sargent who has recognized[5] the propriety of this name as applied to *H. cordiformis,* where it seems to belong, has thrown additional light on this usage. One additional case might be added here. C. D. Mell, in his list of Pennsylvania-German names of tree, give sauer hickory as the name for pignut, referring this name to *H. glabra.* Of the Pennsylvania hickories only the fruit of *H. cordiformis* could be described as *sauer.* His pignut consequently should refer to *cordiformis.*

Until recently the common name exclusively used in literature for *Quercus digitata* (*Q. falcata* Mx.) has been Spanish oak. This oak and all of its forms seems to be known from Maryland, Ohio, and Indiana to Florida and Texas as red oak.[6] Sometimes there is a distinctive designation to indicate site on which it grows as swamp red oak for the variety *leucophylla.*

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[3] Among some of the other most distinct forms which have been referred to *Hicoria glabra,* the so-called pignut, may be mentioned: *Hicoria leiodermis* n. c. (*Carya leiodermis* Sargent, Bot. Gaz. **65**: 239. 1918) which is the common hickory of Louisiana, eastern Texas, and Mississippi on banks of streams. It is related to *H. glabra* but has more numerous leaflets. Its variety *H. leiodermis callicoma* n. c. (*Carya* var. Sarg. op. cit., p. 240) is a frequent form of the preceding with thinner husk to the fruit.

Hicoria floridana n. c. (*Carya floridana* Sarg., Trees and Shrubs **1**: 193. 1911). Peninsular Florida. Related to *H. glabra.* but fruit ripens in midsummer.

Hicoria buckleyi villosa n. c. (*Hicoria glabra villosa* Sarg., Silva **7**: 167. 1895).

[4] Proc. Soc. Am. For. **11**: 233. 1916.

[5] Botanical Gaz. **66**: 232. 1918. Also Manual Ed. 2: 180, 192.

[6] *Quercus cuneata triloba* n. c. Southern red oak, 3-lobed leaf form. *Quercus triloba* Mx., Chenes, 14 t. 26, 1801. *Quercus cuneata pagodaefolia* n. c. (*Q. falcata* var. Ell., Sk. **2**: 605. 1824). Southern swamp red oak, many lobed leaf form. A very large and valuable tree. *Quercus cuneata leucophylla* n. c. (*Q. rubra leucophylla* Ashe, Bul. Ch. Mus. **13**: 25. 1917). One of the largest trees of the South Atlantic and Gulf Coasts.

SOME POINTS IN THE BUD DEVELOPMENT OF A SIMPLE ASCIDIAN, *ECTEINASCIDIA TURBINATA* HERDMAN[1]

By C. Dale Beers

In the *Clavellinidae* the stolon consists of an outer ectodermal tube enclosing an inner so-called epicardial tube, endodermal in origin, the two tubes being separated by a blood sinus. The outer tube arises from the ectodermal body wall of the larva, while the epicardial tube is derived from the branchial sac of the larva. In *Clavellina* and *Perophora* the walls of the inner tube are approximated so that it has the structure of a double-walled septum which divides the outer tube into longitudinal halves, the septum stopping short of the distal end of the stolon. The two lateral blood spaces of the stolon remain in connection with the sinuses of the embryozooid from which it has developed. In *Ecteinascidia* on the contrary, the inner tube preserves its tubular shape. Transverse sections show that the shape is irregular. In places the tube has no contact with the surrounding ectodermal tube. In other places its wall is at certain points in close contact with the ectodermal wall. Thus the space separating the two tubes is not a simple undivided space but consists rather of a set of sinuses continuous with one another.

The bud primordium of *Ecteinascidia* is not unlike that of other members of the family, and is made up of two vesicles, one within the other, separated by a blood sinus. The outer or ectodermal vesicle arises as an evagination from the outer tube of the stolon, the inner vesicle as an evagination from the inner stolonic tube. It is the inner or endodermal vesicle which is particularly concerned in the organogeny of the bud. From it develop not only the structures which are derived from the endoderm in egg development, but others, such as the nervous system and peribranchial sacs, which come from the ectoderm of the egg embryo. It is this contrast in the embryogenic methods of larval development and bud development which demonstrates that the idea of histogenetically specialized germ layers is inapplicable to the Ascidians.

[1] The material used in this study was collected in the Bahama Islands by Professor H .V. Wilson. Although old, its histological condition is good. Professor George Lefevre kindly identified for me the form as *Ecteinascidia turbinata*.

Three organ systems which very early make their appearance are the pericardium and heart, the hypophysis and its associated structures, and the gonads. These organs all develop as Lefevre[2] has described, from proliferating areas of the wall of the inner vesicle to which possibly free mesenchyme cells add themselves. My observations confirm Lefevre's account. The primordium of the hypophysis appears at the extreme anterior end of the inner vesicle. The mass of cells which is produced by proliferation later acquires a lumen and assumes the form of a tube which lies along the mid-dorsal line. The ganglion develops by proliferation from the dorsal wall of the hypophysis, the subneural gland as a proliferation from its ventral wall. The pericardium appears as a proliferation from the right side of the inner vesicle in the posterior region. The mass becomes hollowed out to form a vesicle, one side of which invaginates to form the heart. The sex organs develop by proliferation from the left side of the inner vesicle, the single primordium acquiring a lumen and dividing into two, an ovary and a testis.

In the anterior region of the body (Fig 1). the peribranchial sacs (*l.p.s, r.p.s.*) are cut off from the more central part of the inner vesicle (*br. s.*) by ventrolateral folds which grow upward and meet each other, thus separating off a median portion or atrium as well as the lateral parts. In the posterior region of the body on the contrary, these folds do not meet each other, but grow upward and meet the original dorsal wall of the inner vesicle. They thus cut off two lateral sacs which are entirely independent of each other at this level.

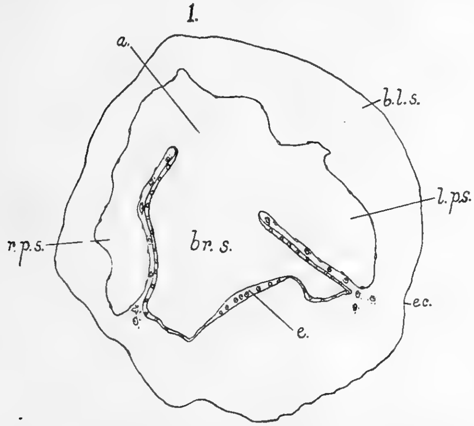

Fig. 1.—Section of bud, transverse to long axis of latter. *a.*, atrium; *bl. s.*, blood sinus; *br. s.*, branchial sac; *e.*, endostyle; ec., ectoderm; *l.p.s.* and *r.p.s*, left and right peribranchial sacs. x 133.

Between these two sacs along the mid-dorsal line lies the terminal portion of the intestine as it passes forward to open into the cloaca. Sections of adults show that these posterior extensions of the peribranchial sacs never unite dorsally. In early stages the left peri-

[2] Geo. Lefevre, Budding in *Ecteinascidia*. Anat. Anz. Bd. 13, No. 18. 1897.

branchial sac extends further back than the right, due no doubt to complications which arise on the right side as a result of the formation of the heart. The lateral sacs later become symmetrical. Lefevre (loc. cit., p. 476) has likewise described the cloaca as developing from the inner vesicle by ventro-lateral folds. However, he describes the folds as meeting each other along the whole length of the body, thus cutting off a median atrium in the posterior as well as in the anterior region. Lefevre (loc. cit.) states that it is the anterior portion of the cloaca that is first cut off, and that the process proceeds posteriorly. Since this also appears to be the case in my material, and since Lefevre merely studied early stages, it is quite likely that the later development of the posterior ends of the peribranchial sacs was overlooked by him.

2.

Fig. 2.—From a section of bud, transverse to long axis of latter. The portion of the section shown includes a part of the wall of the branchial sac. *b.w.*, with the adjoining peribranchial wall, *p.w.* A fully formed stigma is shown at *b.s.*; *th.* and *e. th.* represent stages in development of same; *m.c.*, mesenchyme cell. x 300.

A second feature of development worthy of special comment is the origin of the branchial stigmata. These are usually described as arising as evaginations from the branchial sac. According to the usual account (e. g., Lefevre[3]) a thickening of the branchial wall occurs, followed by a slight evagination which brings the branchial wall in contact with the peribranchial wall. These apposed surfaces become intimately fused, the stigma breaking through the area of fusion.

However, in *Ecteinascidia,* my preparations clearly show that the stigmata are formed in a slightly different way. The first indication of a stigma is an unmistakable thickening of the peribranchial wall, as indicated at *th.* in Fig. 2. A slight evagination of this thickened peribranchial area follows (*e. th.*). The basement membrane of the epithelial wall of the inner vesicle then disappears opposite the thickening, the peribranchial and branchial walls thus fusing. This area of fusion soon becomes perforated by the stigma. The series of steps in the formation of the stigmata was followed in five buds, all of about the same stage. The stigmata later become fringed with cilia in the usual manner. They first appear in the middle of the bud, the tendency to arrange themselves in vertical rows being evident at the beginning.

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[3] Geo. Lefevre. Budding in *Perophora.* Journ. Morph. **14**: 387. 1898.

BREEDING HABITS OF LIMNORIA AT BEAUFORT, N. C.

By R. E. Coker

Notwithstanding the general interest that is periodically manifested in destructive marine borers of all kinds, there has been a notable lack of definite information regarding the essential features of life history of most species. This applies particularly to the little isopod, *Limnoria lignorum*, which is of extremely wide distribution and particularly destructive in Southern American waters. *Limnoria* has been observed and collected in innumerable localities—on the Atlantic coast from Florida to the Gulf of St. Lawrence, in the Pacific Ocean, in the North Sea, in the Adriatic, on the coast of Great Britain, etc.[1] Yet there are practically no references in the literature to examples carrying eggs or embryos in the brood pouches.

Through the courtesy of the United States Bureau of Fisheries and the interested and efficient coöperation of Mr. Charles Hatsel, Superintendent of the U. S. Fisheries Biological Station, Beaufort, N. C., periodic collections of *Limnoria* from wharf piles on Pivers Island, Beaufort, N. C., have been made for me for a period of more than a year, beginning May 1, 1922. Only a preliminary examination of the material has yet been made; but, in view of the fact that a number of agencies and investigators are now engaged upon experiments to determine means of prevention of the attacks of marine borers of all kinds, including *Limnoria*, it is worth while to give out the information available regarding the breeding season and habits of *Limnoria*.

As is true of other isopods, development in *Limnoria* is direct, the eggs being carried in infra-thoracic pouches until the young isopods are fully formed and set free to begin boring into the wood probably in close proximity to the maternal parent.[2] The eggs or embryos found in a pouch are almost invariably of approximately identical condition of development, indicating that the entire brood is deposited in the pouch at one time. A single exception to this rule was noted with an

[1] Richardson, Harriet. Monograph of the Isopods of North America. Bulletin U. S. National Museum, No. 54, Washington, 1905. Richardson recognizes but one species including all examples in the National Museum, from whatever part of the world.

[2] Observations on new borings at Woods Hole, Mass., indicate that a sexual pair is commonly found in a single burrow, the female being nearest the blind end of the burrow. This suggests that the female does the work of excavation.

example taken April 30, 1923, which had 6 eggs and one nearly fully developed larva in its brood pouch. The number of eggs or young carried by an individual is quite variable, and, as will be noted later, there is evidently a certain seasonal variation in the mean number of eggs per brood.

For the period during which these collections have been taken, Mr. Hatsel has made special observations of temperature and specific gravity of the water at the pier of the Beaufort Laboratory. As far as practicable, records have been made twice daily, once at high tide and once at low tide. I have grouped the records of temperature for high and low water respectively, by five day periods and the accompanying table (p. 99) gives the maximum, the minimum, and the mean for each unit period from May 20, 1922 to May 19, 1923. A precise correspondence is not found between temperature of water on the one hand and cessation of breeding in fall and resumption in spring. But, if temperature is the controlling factor, it is obvious that gravid examples will be found for some time after the cessation of breeding activities, and it may be expected that, after the temperature in spring rises to a point favorable to the development of the gonads, another period may elapse before breeding activities become manifest in the discharge of eggs and filling of the brood pouches.

Examination of the temperature records shows that prior to November 20, 1922, there had been occasional low readings of 14°C., although the average for no five day period had fallen below 16°C. There followed a sudden fall of temperature to a minimum of 10° and an average for the next five day period of 13.4° (means of temperatures at high and low water combined). Four immediately ensuing five day periods (Nov. 26-Dec. 15) gave means of 9.4°, 10.6°, 14.1°, and 11.9°. Some gravid *Limnoria* were found up to December 12, but not later. As a matter of fact, *eggs* (without evident development) were not found in any collection after October 26, at about which time minimum temperatures of 14°C. first occurred, means for a five day period being then at about 17°.

During the remainder of the winter the averages for five day periods varied from 11.3° to 5.7°, the lowest being in February. With the first five days of March the mean rose from 7.6° in the last week of February to 10.3°, and there was no subsequent serious slump. Between March 11 and 15 there was a temporary rise to a maximum of 17° and minimum of 14°, with a mean for the period of 15.4°. In ensuing periods the temperatures were, of course, variable, but means

of approximately 14° or higher are found for all subsequent five day periods except for the period March 31 to April 4, when, owing to a sharp and very brief drop to a minimum of 8°, the mean was as low as 11.9°. By April 14, when the mean temperature was about 16° and the minimum above 14° for the first time since autumn, a very substantial proportion of large Limnorias were gravid. As previous collections in 1923, including one as late as April 3, showed no gravid examples, and, as all eggs borne by the specimens taken April 14, were apparently newly laid, it may be assumed that breeding began rather suddenly on April 14 or within a few days prior thereto.[2].

If, then, temperature is an effective factor in determining the limits of the breeding season of *Limnoria*, the data in hand would fit with the assumption that the production and deposition of eggs at Beaufort, N. C., ceases when the minimum temperature in autumn falls to about 14°C. and that the rise of temperature in spring stimulates a renewal of breeding activity which is reflected in the filling of brood pouches after the minimum temperature passes above 14°C. The period during which no eggs or embryos were formed in the brood pouches covered approximately four months (one-third of the year) from about the middle of December to about the middle of April. Of 29 collections made from May 1, 1922, to December 12, 1922, inclusive, only two included no gravid females and these were made November 7 and 30. Of 11 collections made December 19, 1922, to April 3, 1923, inclusive, none contained gravid *Limnoria*.

As previously indicated, all eggs observed April 14 were apparently new-laid. In 12 gravid examples taken April 21, several had embryos showing substantial development, but only one had well formed larvae. Of 38 gravid examples, an exceptionally large number, taken April 30, more than one-fourth bore well advanced larvae and about one-tenth were apparently fully developed. Of 10 examples collected May 7, more than one-half bore fully developed larvae. These results suggest that the incubation period, at this season of minimum temperatures for breeding, is 2 weeks or a little longer.

Breeding starts in spring with a real impetus. By April 30, practically all large females were gravid and in all the early collections the brood pouches regularly contained large numbers of eggs or embryos. In summer and fall pouches are often found to contain but

[2] The first collection of 1922, made May 1, had a high proportion of gravid females, including both eggs and advanced embryos.

one or two eggs, six is a high number, and nine was the maximum observed in 1922. The mean number of eggs per brood pouch varied in the several collections made from May 1 to December 12 from 1.5 to 4, but the means of actual numbers in the live *Limnoria* would have been a little higher, for some eggs and larvae are lost from the brood pouches in processes of preservation and shipping. In the early spring collections of 1923, eight, nine and ten were not uncommon numbers of eggs per brood pouch, twelve was the maximum observed (April 30) and the mean number per brood pouch for the collections of April 14, 21, and 30, and May 7, 15 and 23, were, respectively, 5.5, 5.5, 6.6, 4.2, 5.3, and 5.

The salinity of the water alongshore of Piver's Island varies to some extent with the tide. There may be a difference in specific gravity of .006 between high and low tides, although ordinarily the difference is not more than .002—.004. The variations from day to day or season to season, according to conditions of rainfall, are much greater. Thus the extremes found in Mr. Hatsel's records for the period from May 1, 1922, to April 30, 1923, are 1.0232 for certain days in January and February and 1.008 in August. Densities above 1.020 or below 1.012 may be sustained for several days, but the reading of 1.008 occurred only once. The available observations indicate only that exposure for several days to water of a density either as low as 1.011 or as high as 1.0021 appears to have no unfavorable effect upon *Limnoria* at Beaufort.

CHAPEL HILL, N. C.

TEMPERATURES OF WATER, PIVER'S ISLAND, BEAUFORT, N. C.
MAY, 1922, TO MAY, 1923

Period 1922-1923	Low Tide				High Tide				Mean of all Readings
	No. Records	Mx.	Mn.	Mean	No. Records	Mx.	Mn.	Mean	
May 20-24	5	28	25	26.8	5	28	25	26.4	26.6
May 25-29	5	28	22	25.2	5	26	23	24.6	24.9
May 30-June 3	5	25	23	23.8	5	25	22	23.8	23.8
June 4-8	5	28	25	26.2	5	28	24	25.8	26.0
June 9-13	5	30	25	27.6	5	28	25	26.6	27.1
June 14-18	5	26	23	24.6	5	27	24	25.6	25.1
June 19-23	5	28	26	27.2	5	27	26	26.8	27.0
June 24-28	5	28	27	27.8	5	28	25	26.8	27.3
June 29-July 3	5	30	27	28.2	5	30	28	29.4	28.8
July 4-8	5	29	26	27.8	5	28	25	26.6	27.2
July 9 13	5	30	28	29.0	5	29	28	28.2	28.6
July 14-18	5	28	26	27.2	5	29	27	27.8	27.5
July 19 23	5	29	27	27.8	5	28	25	27.0	27.4
July 24-28	5	29	28	28.6	5	29	28	28.8	28.7
July 29-Aug. 2	5	29	27	27.6	5	29	28	28.8	28.2
Aug. 3-7	5	29	28	28.2	5	28	27	27.6	27.9
Aug. 8-12	5	28	24	25.2	5	27	24	25.6	25.4
Aug. 13-17	5	28	24	26.6	5	28	26	27.2	26.9
Aug. 18-22	5	27	24	25.2	5	28	23	25.0	25.1
Aug. 23-27	5	27	25	25.8	4	27	24	25.7	25.7
Aug. 28-Sept. 1	5	29	25	26.2	5	27	24	25.6	25.9
Sept. 2-6	5	29	27	26.4	5	28	25	26.8	26.6
Sept. 7-11	5	28	25	27.0	5	28	27	27.6	27.3
Sept. 12-16	5	27	26	26.4	4	27	27	27.0	26.6
Sept. 17-21	3	23	19	21.6	5	24	19	20.8	21.1
Sept. 22-26	5	20	18	19.0	4	20	18	19.0	19.0
Sept. 27-30	4	22	18	20.5	4	22	19	21.2	20.8
October 1-5	5	24	22	22.8	5	24	22	22.4	22.6
October 6-10	3	25	23	24.3	5	24	23	23.8	24
October 11-15	5	22	18	20	3	23	19	20.7	20.3
October 16-20	4	20	18	19	5	24	17	20.6	19.9
October 21-25	3	19	16	17.3	4	18	14	16.2	16.7
October 26-30	5	20	14	17	4	20	14	17.5	17.2
November 1-5	2	18	18	18	4	19	17	17.5	17.7
November 6-10	3	19	16	18	5	20	17	18.6	18.4
November 11-15	4	20	15	18.6	1	18	18	18	17.4
November 16 20	3	17	16	16.3	4	18	15	16.7	16.6
November 21-25	5	15	10	12.8	5	15	11	14	13.4
November 26-30	4	14	8	9.7	3	10	8	9	9.4
December 1-5	4	15	8	10.7	4	14	8	10.5	10.6
December 6-10	4	15	13	16.7	3	15	13	14	14.1
December 11-15	4	13	10	11.5	4	14	10	12.2	11.9
December 16-20	3	12	8	10.7	4	13	9	11.7	11.3
December 21-25	4	10	9	9.2	3	13	9	10.7	9.9
December 26-30	3	12	8	10	3	12	8	10.7	10.8
Dec. 31-Jan. 4	4	12	9	10.5	5	12	10	10.8	10.7

TEMPERATURES OF WATER, PIVER'S ISLAND, BEAUFORT, N. C.
MAY, 1922, TO MAY, 1923
(Continued)

Period 1922-1923	Low Tide				High Tide				Mean of all Readings
	No. Records	Mx.	Mn.	Mean	No. Records	Mx.	Mn	Mean	
January 5-9	5	12	10	11	5	13	10	11.6	11.3
January 10-14	5	10	8	8.8	4	10	8	9.2	9
January 15-19	5	11	7	8.2	5	12	5	9	8.6
January 20-24	5	13	8	10.8	5	13	9	11	10.9
January 25-29	4	12	8	10.2	5	12	10	10.8	10.6
Jan. 30-Feb. 3	4	13	8	11.2	4	12	8	9.5	10.4
February 4-8	5	9	4	6.4	5	10	5	7.2	6.8
Feruary 9-13	4	8	6	6.7	2	9	8	8.5	7.3
February 14-18	5	12	5	7.4	5	12	5	7.2	7.3
February 19-23	4	5	5	5	2	8	7	7.5	5.7
February 24-28	5	10	5	7.6	3	10	6	7.7	7.6
March 1-5	3	13	10	11.7	4	12	8	9.2	10.3
March 6-10	3	12	8	10	4	12	8	10.5	10.3
March 11-15	4	17	14	15.5	3	16	14	15.3	15.4
March 16-20	4	16	12	14.2	4	14	12	13.5	13.9
March 21-25	5	17	13	15.6	2	17	14	15.5	15.6
March 26-30	4	18	8	14.7	4	18	12	15	14.9
Mch. 31-Apr. 4	2	15	12	13.5	5	15	8	11.2	11.9
April 5-9	4	19	13	16	2	17	12	14.5	14.8
April 10-14	4	17	13	15.5	2	16	15	15.5	15.5
April 15-19	2	15	15	15	5	15	10	13.4	13.9
April 20-24	5	20	16	18.2	4	19	16	17.7	18
April 25-29	3	18	17	17.3	4	18	14	17	17.1
April 30-May 4	3	22	20	20.7	4	18	18	18	19.1
May 5-9	4	18	17	17	5	20	18	18.6	17.9
May 10-14	3	20	17	18	4	19	17	18	18
May 15-19	5	24	21	23	4	23	20	20.7	22

DEVELOPMENT OF THE FRUIT-BODY OF A NEW PARASITIC RHIZOPOGON*

By H. R. Totten

Plates 1-7

The very remarkable plant described here was first found by us on the roots of *Pinus echinata* and *Pinus taeda* in the winter of 1920. A short report of it was made before the meeting of the North Carolina Academy of Science, May 1, 1920 (14). Since that time it has been under rather constant observation, and fruit-bodies have been found from late summer through the winter. The plant is small and inconspicuous, the fruit-body rarely reaching a diameter of 1.5 cm., yet it shows an interesting case of parasitism and a hitherto unknown method in the development of the fruit-body in a Gasteromycete. Fischer (4) has described the formation of the chambers in *Rhizopogon,* but he did not describe the very young stages.

The work has been carried on under the direction of Dr. W. C. Coker and I wish to express my appreciation of his suggestions, criticisms, and revisions. He is joint author of the species here described. Dr. J. B. Bullitt has been of great assistance in the micro-photographic work. The micro-photographs shown in plate 5 and the lower one in plate 6 were made by him with a simplified micro-photographic apparatus that he designed and made. (This apparatus was described by Dr. Bullitt before the 1923 meeting of the North Carolina Academy of Science.) Dr. Bullitt has also given valuable advice on other micro-photographs, and he cut and stained the material shown in the upper figure of plate 5. Miss Alma Holland has inked in the camera-lucida drawings.

Rhizopogon parasiticus Coker and Totten n. sp.

Fruit-body up to 1.5 cm. broad and high, though usually much smaller, the great majority about 2-5 mm., sometimes almost evenly globose but more often lobed and convoluted; attached at any point to one or several branching, flocculent, rhizomorphous threads which

* This paper is part of a thesis submitted to the Faculty of the University of North Carolina in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Botany.

run in the humus and connect the fruit-bodies on different roots; rarely some of these branching threads may run along and cohere with the surface of the fruit-body; color of both mycelium and the fruit-body varying from a light ochraceous salmon to a warm buff at all ages until decay sets in. Peridium of mature plants duplex, 50-130μ thick, the outer layer a spongy mass of loosely woven threads that collapse when the plant is cut or bruised or when decay sets in; the inner layer more closely woven, lighter in color and intimately connected with the internal hyphae; threads of the peridium soft and delicate, 2.6-10.4μ thick, in young plants more closely woven.

Gleba when fully formed containing many cavities that are minute, irregular, 20-200μ broad, hollow and lined with the hymenium. Septa 40-115μ thick, delicate and intimately connected with the peridium, the threads that compose them much branched, segmented, thin-walled, without clamp connections, 2.6-10.4μ thick and having much the appearance of those of the peridium. The hymenium contains no obvious specialized cystidia, but certain cells among the basidia are of more fusiform shape and these have not been seen to bear spores. One such is shown at the top of figure 7 on plate 7.

Spores brown, fusiform, smooth, 3-3.5 x 7.8-10.4μ. Basidia short-clavate, 5 x 17μ, 2-4-spored, with slender sterigmata, which are 2.5-3.5μ long.

Gregarious and often crowded in large numbers in connected colonies in humus just under or at the surface, and parasitic on rootlets of pine in damp places.

3990. On roots of *Pinus echinata* and *Pinus taeda*, by branch south of Pritchard's, January 10, 1920.

5383. Same place as No. 3990, July 22, 1922.

6051. Roots of *Pinus taeda*, edge of swampy place north of cemetery, January 19, 1923.

6057. Same place as No. 3990, January 28, 1923.

The fruit-bodies arise from a thin, flocculent weft of mycelium that surrounds the succulent roots and follows and covers the lateral rootlets, causing them to form a dense glomerulus of very short branches around and in which the fruit-body is formed. The fungal coats of several rootlets soon coalesce into a light buffy mass of various forms and sizes, the ends of the rootlets covered over with the fungal threads give a convoluted appearance to the surface of the young

fruit-body. After full size is reached the mass of rootlets which has occupied by far the greater part of the body is quickly attacked and destroyed by the internal fungus threads and their place is taken by the gleba. In this invasion of the pine tissue the fungus sends first single threads that force their way between the pine cells, as shown in lower figure of plate 4; and then later by repeated branching of these cells the fungus invades in almost solid sheets, as shown in the upper figures of plate 5 and in figure 1 of plate 7. First the cortex region and then the xylem region is completely destroyed. After maturity first the hymenium and then the entire gleba undergoes deliquescence and becomes a dark brown, tasteless slime with a faint odor of iodoform; a very small sub-glebal portion remains sound for a time, but later it too deliquesces. The very delicate peridium soon water-soaks; the outer layer collapses; the inner layer remains for a time as a thin, delicate membrane, the plant then having the consistency of a minute bladder filled with a thin, dark jelly. Later this thin coat disorganizes to allow the escape of the slime.

The true position of this plant is somewhat doubtful. The partly subterranean habit, absence of a capillitium, gleba not becoming a powdery mass, and the indehiscent peridium, would place it in the *Hymenogastrineae.* The absence of a sterile columella excludes it from the *Secotiaceae.* Fischer's (4) drawings of the young fruit-body of *Hysterangium* superficially resemble sections of our young plants, but only superficially for the branching central portion of *Hysterangium* is made up of fleshy strands of fungal material; while this appearance in our young plants is due to the roots of the pine. These roots later disappear entirely. In the *Hysterangiaceae* the whole interior of the fruit-body develops from these fleshy strands and the tramal plates radiate towards the peridium. In our plant growth is from without in, and the tramal plates do not radiate towards the peridium. These are characters of the *Hymenogastraceae.* In this family the presence of the root-like strands below the fruit-body and the absence of the papilla at the end of the spore exclude our plant from *Hymenogaster;* while the smooth, fusiform spores exclude it from *Octaviania, Hydnangium, Sclerogaster,* and *Lycogalopsis.* The absence of the gelatinous mass in the glebal chambers excludes it from the genus *Leucogaster*; and the hollow chambers with the well defined hymenium exclude it from *Melanogaster.* The soft, loosely woven

character of the peridium that in fresh plants before the collapse of the threads in very old fruit-bodies is far from coriaceous; and the rarity in which the rhizomorphous threads, or fibrils, run along and cohere with the surface of the peridium, throw grave suspicion on the position of this plant in the genus *Rhizopogon*. In this genus, however, the abundance and prominence of these fibrils varies greatly. Zeller and Dodge (17) in their excellent monograph on *Rhizopogon* include in that genus *Rhizopogon maculatus* Zeller & Dodge, a plant with the outer peridium loosely woven. As the method of developing the fruit-body in our plant is so different from anything we have found described, it is quite likely that the plant belongs to an undescribed genus. Yet since so little is known of the development of the other members of this group we have thought it best to describe the plant as a species of *Rhizopogon*.

Mycorhizal Character

Quite a mass of literature has developed upon the subject of mycorhizas since Frank's (5 & 6) excellent pioneer works on this subject. He described mycorhizas on a number of plants, and described the two types of mycorhizas: *ectotrophic*, or mycorhiza where the fungal threads do not live within the host cells; and *endotrophic* where the fungal threads do occupy the living host cells. He claimed there was a symbiotic relation between the fungal threads and the host. Even before Frank's papers Tulasne, as pointed out by MacDougal (9), noted that *Elaphomyces* forms coatings on the roots of pine. MacDougal takes this reference from Tulasne's Fungi Hypogaei, 1851. We have not examined this edition; but in the edition of 1862 (15) Tulasne does not name the pine as the host of *Elaphomyces;* but he does have quite a discussion as to whether the *Elaphomyces* is parasitic on the tree rootlets or whether, as Vittadini had suggested, the rootlets profited by the presence of the fungus. He concludes that the parasitism of *Elaphomyces* is very problematical, if not improbable for the greater number of them. Groom (7) showed that there is a mutual exchange of material between the host and fungus in the mycorhiza of *Thismia,* and claimed that the weight of evidence at that time supported the symbiotic view of mycorhizas as held by Frank, but he says: "Mycorhiza is, then, either a highly adapted and symbiotic community beneficial to both symbionts, or it is a pure matter of infection of a plant by a fungus, and there is a constant struggle

between the host and the would be parasite." In support of this last view he calls attention to the fact that E. Bruns (2) had shown that *Polysaccum* causes an ectotrophic mycorhiza of pine roots, and that "some of the hyphae actually dip deep into the tissue of the root, at the same time absorbing so vigorously as to play havoc with the infected tissues."

The earliest observers of mycorhizas thought that *Elaphomyces* and tubers or truffles caused all the ectotrophic mycorhiza. Gradually the list of fungi known to cause mycorhiza has been enlarged. MacDougal (9) in 1899 gave a list of the fungi known at that time to produce mycorhiza. The list included species of *Fusiporium, Eurotium, Pythium, Nectria, Celtidia, Elaphomyces, Polysaccum, Geaster, Boletus, Lactarius, Cortinarius, Tricholoma,* and *Agaricus.* Of these *Elaphomyces, Polysaccum, Geaster, Boletus, Tricholoma,* and *Agaricus* formed mycorhizas with the conifers, some of these with other plants too. Kauffman (8) has shown that *Cortinarius rubipes* forms mycorhizas on red oak, sugar maple, and *Celastrus scandens.* Pennington (13) in 1910 reported that a species of *Cortinarius* and "probably a form of *Russulu emetica*" produced mycorhizas upon the red oak, and that *Boletus speciosus* and *Tricholoma transmutans* produced them upon the black oak. McDougall (10) added four species to the known list of ectotrophic mycorhiza-forming fungi: *Russula* sp. on *Tilia americana, Boletus scaber fuscus* on *Betula alba* var. *papyrifera, Cortinarius* sp. on *Betula alba* var. *papyrifera,* and *Scleroderma vulgare* on *Quercus alba.* He showed that at least four, and probably more, different species of mushrooms may form mycorhizas on the same tree. He also showed that the endotrophic mycorhizas of the maples are sometimes symbiotic associations, and sometimes associations in which the fungus is surely a parasite of the roots; but that the ectotrophic mycorhizas of forest trees are not symbiotic associations, but instances of parasitism of fungi on the roots of trees. This opinion is reiterated in a later paper (12).

There has probably been more research and publications on the endotrophic mycorhizas than for the ectotrophic forms. Many of them seem to show real symbiosis, or what McDougall (11) terms "reciprocal parasitism." The *Orchidaceae* and *Ericaceae* show generally a mycorhizal condition. MacDougal (9) says that Warhlich examined 500 species of Orchids in cultivation at Moscow and found

all exhibiting mycorhiza. Bower (1) says that the seedlings of the common heather (*Calluna vulgaris*) will not develop roots until infected with the right fungus. Our plant, however, clearly forms the ectotrophic mycorhiza, and no attempt will be made in this paper to review the extensive literature on the endotrophic mycorhizas.

In 1922 McDougall (12) reported a *Cortinarius* sp. with yellow mycelium forming mycorhiza on *Picea rubra* and one with white mycelium on *Abies Balsamea*. He also described a tubercle-like compound mycorhiza on seedlings of *Pinus strobus* from Maine. He says: "So far as I am aware no structures at all similar to these have ever before been described. Coral clusters of mycorhizas containing large clusters of rootlets are well known. Moller reported a cluster on a spruce seedling that, judging from his illustrations, must have contained altogether a total of a hundred or more rootlets and I have frequently seen comparable if somewhat smaller clusters on the roots of oak and hickory species. The case that we are reporting here, however, in which the rootlets are bound together by the mycelium into a compact tubercle seems to be entirely unique." The nodules were pale yellow or buff in color and varied from one to four millimeters in diameter. No sporophores were found. His sketch of a cross section of this compound mycorhiza agrees very well with sketches of our plants. There is also an agreement in color; but we find plants much larger, up to 1.5 cm. in diameter, and we do find sporophores. There is quite a possibility that McDougall had the same plant that we have found on *Pinus echinata* and *Pinus taeda*.

Dr. Collier Cobb (3) in his paper entitled *The Forests of North Carolina* mentions the presence of minute fungi attached to the roots of *Pinus taeda* on Hatteras Island and suggests that the trees may be aided by their presence. I have shown our plants to Dr. Cobb and he is of the opinion that they are the same plants observed by him on Hatteras. He say that he mentioned them in a talk entitled "Hatteras Island" before the 44th meeting of the Elisha Mitchell Scientific Society at Chapel Hill, December 9, 1902; and in one entitled "Hatteras Island and Its Shifting Sands" before the Association of American Geographers in New York in 1906. If McDougall's plants from Maine and those observed by Cobb on Hatteras Island are *Rhizopogon parasiticus*, then this species has quite a wide range. It is so easily overlooked that closer observation may show it to be not uncommon generally.

Rhizopogon parasiticus forms a compound ectotrophic mycorhiza; but the mycorhizal character is short lived and the mass of inclosed rootlets is completely absorbed. The fungus then forms its fruiting surface right in the position that the obliterated pine tissues had held. In the literature cited above we have found no reference to a fruit-body formed in this way. Wolf (16) has shown that the Tuckahoe or Indian-bread is formed by *Poria Cocos* attacking the pine root and forming a large sclerotium within the bark of the root. Later, under certain conditions, a poroid, resupinate fruit-body is formed on the surface of the sclerotium. This *Poria,* though not a mycorhizal fungus, does make an interesting comparison with our plant in that it replaces much, though not all, of the pine tissue of the root.

SUMMARY

1. A new fungus of the *Hymenogastraceae* is described and given the name of *Rhizopogon parasiticus,* though doubt is expressed as to whether the plant is correctly placed in the genus *Rhizopogon* or whether it belongs to an undescribed genus.

2. A review of the work on ectotrophic mycorhizas is given, and *Rhizopogon parasiticus* is shown to form compound ectotrophic mycorhizas on the roots of *Pinus echinata* and *Pinus taeda.*

3. *Rhizopogon parasiticus* gives further proof of the parasitic nature of ectotrophic mycorhizal forming fungi, for the pine tissues of the rootlets invaded by this fungus are completely destroyed.

4. The plant is unique in the way it forms the sporophore, forming a gleba in the space formerly occupied by the invaded cluster of pine rootlets.

CHAPEL HILL, N. C.

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EXPLANATION OF PLATES

(*Rhizopogon parasiticus*)

PLATE 1

Fruit-bodies of various ages on roots of pine. Natural size.

PLATE 2

Clusters of fruit-bodies showing the rhizomorphic threads. x 6.

PLATE 3

(Above) A longitudinal section through a cluster of infected pine rootlets, showing the cluster completely surrounded with fungal threads, also the cortical area of the rootlets invaded. x 40.

(Below) A cross section through a cluster of infected rootlets of same age as in fig. 1. x 40.

PLATE 4

(Above) A longitudinal section through a small root showing parts of three clusters of rootlets surrounded with fungal threads, of same age as shown in plate 3. x 24.

(Below) A more highly magnified view of a part of the section shown in lower figure of plate 3. The infecting fungus can be seen invading the cortical area in single threads. x 190.

PLATE 5

(Above) Section through a plant older than the one in plate 4. The hyphae are now invading in almost solid sheets along the cell walls. x 240.

(Below) Longitudinal section of a fully grown fruit-body, showing hymenial chambers, the pine tissue completely destroyed. x 55.

PLATE 6

(Above) Showing tramal plates, hymenium, and chambers. x 250.

(Below). Part of above. Sterigmata can be seen near the middle of the figure. x 500.

PLATE 7

Fig. 1. Fungal threads attacking cortical cells of the pine, in same stage as shown in upper figure on plate 5. The fungal threads force their way between and over the pine cells which are the unshaded areas in the figure. x 690.

Figs. 2 & 3. Basidia with nearly mature spores.

Fig. 4. Young basidia. x 1290.

Fig. 5. Mature spores. x 1290.

Fig. 6. Tramal thread, showing nuclei. x 1290.

Fig. 7. Trama and hymenium of mature plant, some of the basidia with two, others with four sterigmata. x 1290.

Figs. 4-6 stained to show nuclei.

NOTES ON SHRUBS OF THE SOUTHEASTERN STATES

By W. W. Ashe

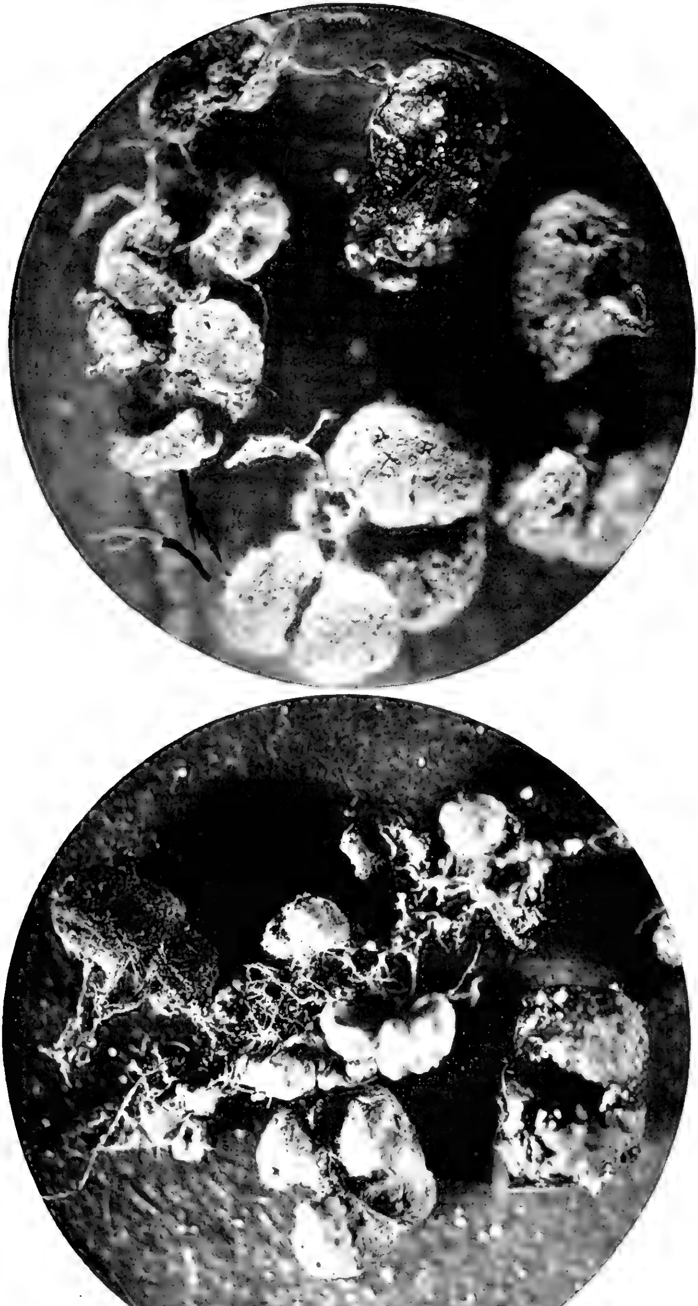
Azalea speciosa Willd. It was suggested in Notes on Azalea published in this journal 38: 90. 1922) that this handsome plant might be looked for in Jackson County, North Carolina. It has recently been found in Macon County, which adjoins Jackson County, thus extending its limited known distribution into another state. *Azalea speciosa* resembles *A. calendulacea* Torr. but has a more slender corolla tube, which is not glandular viscid, as is that of *calendulacea*, and has smaller and relatively broader leaves. Its flowers also are always a brilliant crimson, never yellow or orange. Plants have been collected and it is now in cultivation. It should be in all collections of azaleas wherever it will be hardy. Of this plant Rehder (Azal. of N. A. 132) says that though it was introduced into cultivation more than a century ago and described and figured by European botanists it had never been recognized by an American botanist prior to 1916, having been confused with *A. calendulacea* or with *A. nudiflora*. In 1792 it was figured by Sims as a variety of *nudiflora* and in 1811 it was described by Willdenow from plants growing in the Berlin Botanical Garden. The first known collection of wild plants was by Michaux about 25 miles above Savannah, Ga., where it is one of the most common species.

Robinia Unakae sp. nov. A shrub 2-6 dm. high, propagating by seed as well as by underground stems, and with slender, geniculate, hispid, usually simple, shoots or the shoots sparingly branched near the top; the young twigs and shoots, rachis, peduncle, pedicel and calyx hispid with weak yellow or purplish setae. Leaves of 7-11 broadly ovate or broadly elliptic glabrous leaflets, 3-5.4 cm. long, or the terminal leaflet sometimes larger and nearly orbicular, thin but firm, slightly bronze on unfolding. Racemes numerous, short, spreading or drooping, 2-4-flowered, peduncles 2-3 cm. long., pedicels very slender, longer than the calyx; flowers white and rose-purple, but not showy, large, 22-24 mm. long; calyx broad, tube short, 3-4 mm. long, lobes long-acuminate, more than one-third length of flower. Fruit mostly solitary at the ends of peduncles, 3-7 cm. long, thick, very

PLATE 1

RHIZOPOGON PARASITICUS. Natural size.

PLATE 2

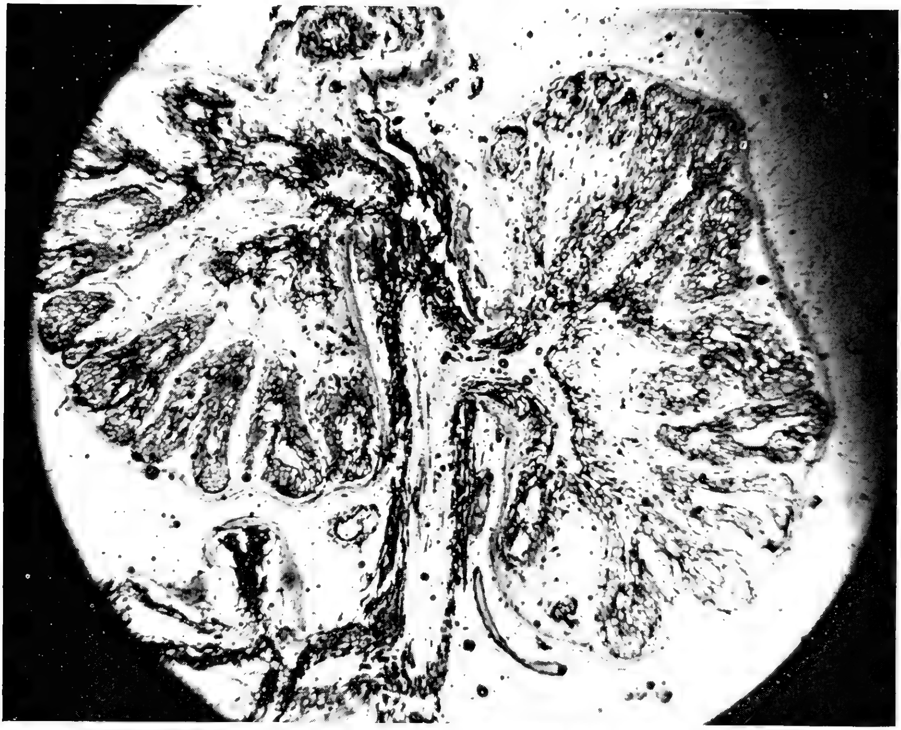


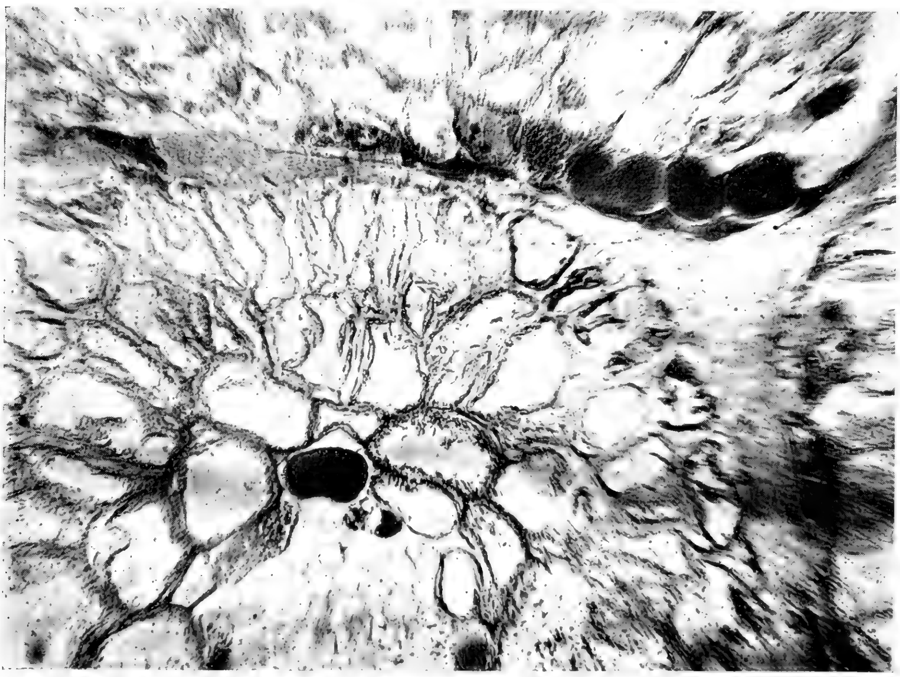
RHIZOPOGON PARASITICUS. x 6.

PLATE 3

RHIZOPOGAN PARASITICUS. x 40.

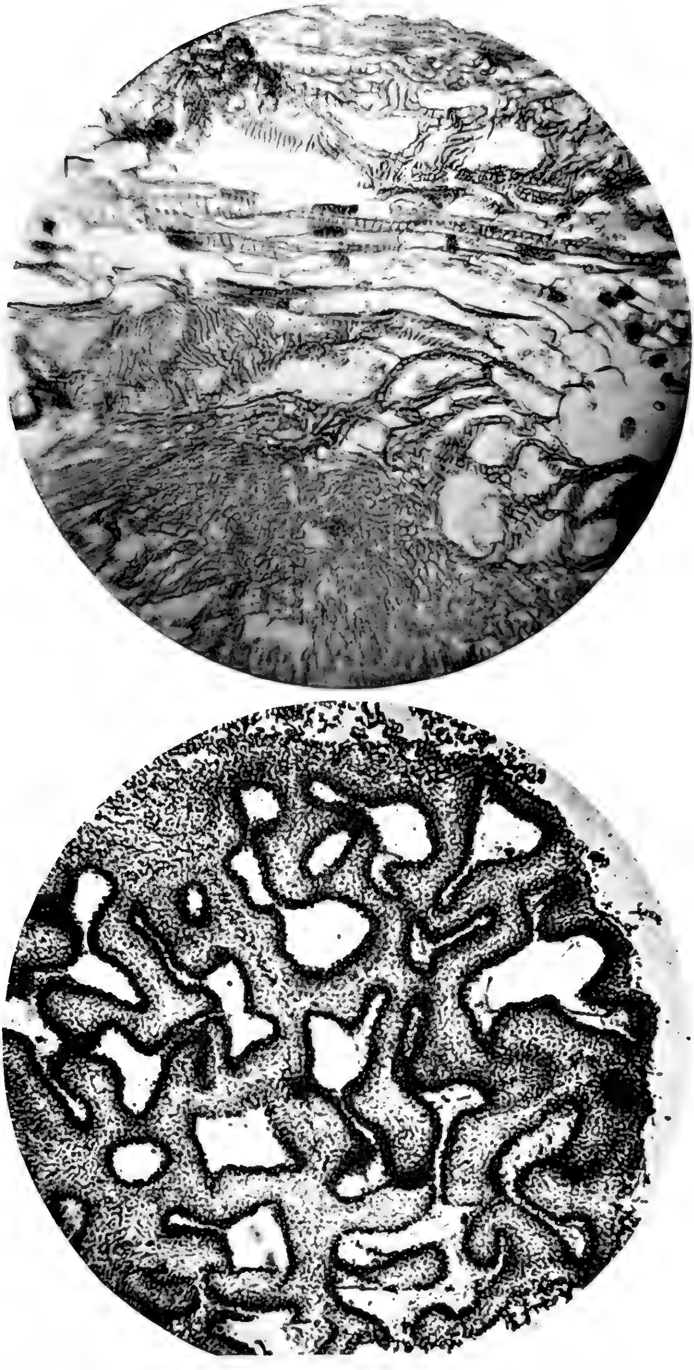
PLATE 4





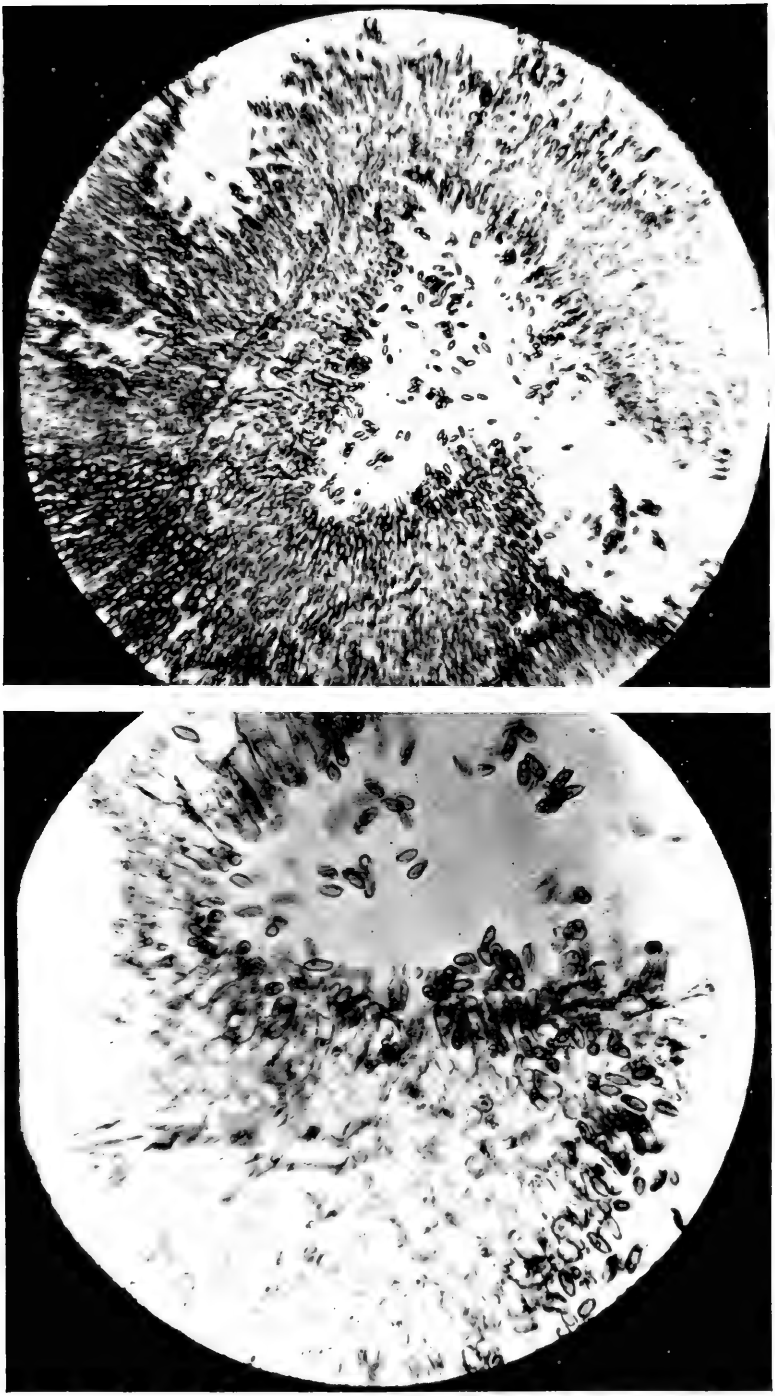
RHIZOPOGON PARASITICUS. Upper figure x 24; lower, x 191.

PLATE 5



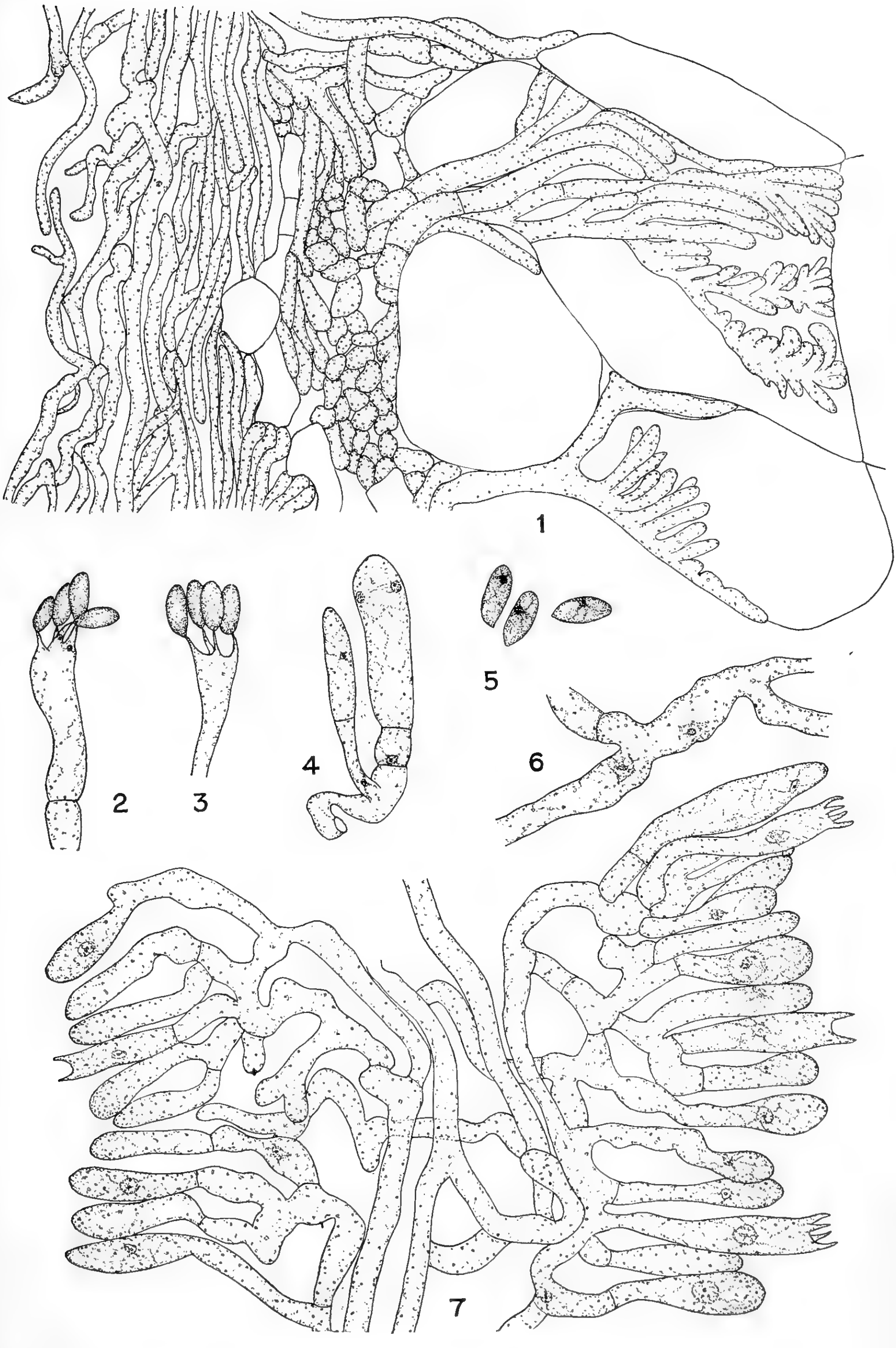
RHIZOPOGON PARASITICUS. Upper figure x 240; lower, x 55.

PLATE 6



RHIZOPOGON PARASITICUS. Upper figure x 250; lower, x 500.

PLATE 7



RHIZOPOGON PARASITICUS

bristly-hispid with stiff greenish setae which at length become dark brown.

Unaka Mountains, North Carolina and Tennessee. Sandstone and shale ridges in pure mountain pine (*Pinus pungens*) forest; less common in chestnut oak, qualities 4 and 5. Type, in cultivation, from near Hot Springs, N. C. This plant has been included in *R. hispida* L. (this Journal **37**: 175) but it justifies separation on account of its thinner and differently shaped leaflets, lower habit, shorter, weaker and paler-colored bristles, less showy flowers and abundant fruiting.

Robinia pedunculata sp. nov. A shrub 1.8-4 dm. high with more or less hispid shoots and peduncles. Leaves 13-17 cm. long of 7-13 ovate or elliptic glabrate leaflets 3-4.5 cm. long. Racemes few, peduncles 7-9 cm. long, fully one-half as long as the leaves, drooping, 7-12 flowered; flowers white and rose, 20-23 mm. long, calyx campanulate, 4-6 mm. long, less than one-third as long as the flower, the lobes short. Fruit, often several to a peduncle, thick, 3-5 cm. long, densely hispid.

Type in cultivation, from sandstone ridges near Wolf Creek, Tennessee. This plant is well separated from all related forms by the many flowered racemes and elongated peduncles.

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A NEW SPECIES OF THRAUSTOTHECA

By W. C. Coker and J. N. Couch

Thraustotheca achlyoides n. sp.

Plate 8

Growth very vigorous but slow, the largest threads sometimes reaching a diameter of 150μ near the base, long, straight or sinuous, rarely or not at all branched. Sporangia formed as in *Achlya* or *Saprolegnia,* of equal or greater diameter than the threads which bear them, not tapering, but often of irregular thickness throughout their length, the tips rounded; the early sporangia straight or with slightly curved tips, the later ones almost invariably with recurved ends. Spores formed as in *T. clavata, Achlya,* etc., but discharged by the breaking away of a considerable part of the end of the sporangium, caused by the swelling of an apical group of spores, after which the spores may emerge immediately or may come to rest to emerge several days later. Usually a few seconds after the cracking of the sporangium the spores of the tip ooze out in a group exactly as in *Thraustotheca.* The spores next below this apical group now swell, extending somewhat the truncated tip of the sporangium and after a few seconds begin to move out in their turn. This continues in a series of partial discharges involving a few layers of spores each time until in about five to ten minutes all the spores become loosened and most of them discharged from the sporangium tip where they are spread out in a loose irregular colony. A few spores are always left in the sporangia. The spores encyst in irregular, not spherical, forms before emerging, and are not connected by threads as in *Achlya,* but exhibit a distinct mutual attraction while emerging as shown for *Dictyuchus* by Weston (Ann. Bot. **32**: 155. 1918). They slide over each other and shift their relative positions but always keep in contact with the emerging mass. Spores usually emerging from their cysts immediately upon discharge, some of them coming out of their cysts even while being pushed from the sporangium. The emergence from the cysts is much more rapid than in *Achlya* or *Saprolegnia,* occupying only about ten seconds. Gemmae not observed. Oogonia formed rarely under laboratory conditions, spherical or slightly ob-

long, 55-100μ thick with smooth walls, borne on lateral stalks which in length are from once to twice the diameter of the oogonia; oogonial stalks usually once coiled, not rarely straight. Eggs 1-8 in an oogonium, 42-60μ thick, rarely up to 77μ thick, but when so large always single in the oogonium; often crowded and elliptical from pressure; structure as in *A. apiculata* with a central sphere of protoplasm surrounded by oil droplets; wall of the egg about 4μ thick. Antheridia apparently not always developed, but when visibly present quite often arising from the oogonial stalk, not rarely diclinous, one to several on an oogonium; antheridial tubes developed.

Found twice at Chapel Hill, from Battle's Branch (October, 1922) and from the branch below Cobb Terrace (November, 1922). The description is made and all figures except No. 10 are drawn from a single spore culture of the last collection. This remarkable plant differs from all other water molds in the details of spore behavior and discharge, but the essentials of this process are like those in *Thraustotheca* and it is best to consider it a species of that genus. In *Thraustotheca* it has not been noted that the spores swell locally in a certain area of the sporangium, but it seems to me probable that this is the case. It is certainly so to a marked degree in the peculiar, intermediate species, *Achlya dubia* Coker (Saprolegniaceae, p. 135. 1923). The angular shape of the encysted spores is also a *Thraustotheca* character and is a result of the early encystment while still under compression in the sporangium.

It is very probable that some mucus material is the cause of the extension of the spores though no one has yet been able to demonstrate it. The discovery of the species *Achlya dubia* has already broken down any sharp distinction between *Achlya* and *Thraustotheca*, as some of its sporangia behave as in *Achlya* and others as in *Thraustotheca*. The present species makes a distinction still more difficult by introducing a new combination of features, an elongated, subcylindrical sporangium becoming truncated by the separation of a cap and the spores escaping by slow degrees in angular shapes after encystment. In order to include the present species and exclude *Achlya dubia* the genus may be defined as similar to *Achlya* except that the spores encyst in an angular shape in the sporangia and in all or most cases escape by slow degrees by oozing out after the cracking of the sporangium, in no case escaping promptly through an apical papilla. It is unfortunate that the egg structure in the two species of *Thraus-*

iotheca is not the same and indicates no closer relationship than in different groups of *Achlya.* In its sexual reproduction the present species resembles *Achlya megasperma* in the size and structure of the oogonia, eggs and antheridia, but differs in usually having coiled oogonial stalks and androgynous antheridia.

The sporangia of *T. achlyoides* usually begin to appear about 36 hours after inoculation and if the food supply is ample they continue to be formed for two weeks or not rarely longer. The following observation was made on a culture March 24 on a small piece of lima bean in sterile well water. When examined March 27th many sporangia were discharging spores. On April 17th there were many empty sporangia with spores and empty cysts spread out on the bottom of the dish; no sporangia were seen emptying at this time though watched for fifteen minutes; a good many sporangia were apparently in a resting condition, a few with tips broken off and others without broken tips. Fresh water was added and the spores in the sporangia with broken tips began to emerge shortly; the other sporangia also soon discharging their spores as usual. These observations have been repeated several times with similar results.

The oogonia, as has been mentioned above, have been formed rarely in our cultures and then occurred on pieces of boiled corn grain in sterile well water about two weeks after inoculation. Various media have been employed to induce the formation of sexual organs, including 0.05% haemoglobin plus a trace of levulose; equal parts of 0.05% haemoglobin and 0.05% leucin; equal parts 0.05% leucin and 0.05% levulose; and 0.1% levulose; but all without success.

CHAPEL HILL, N. C.

EXPLANATION OF PLATE 8

Fig. 1. A sporangium with swollen apex just before breaking.

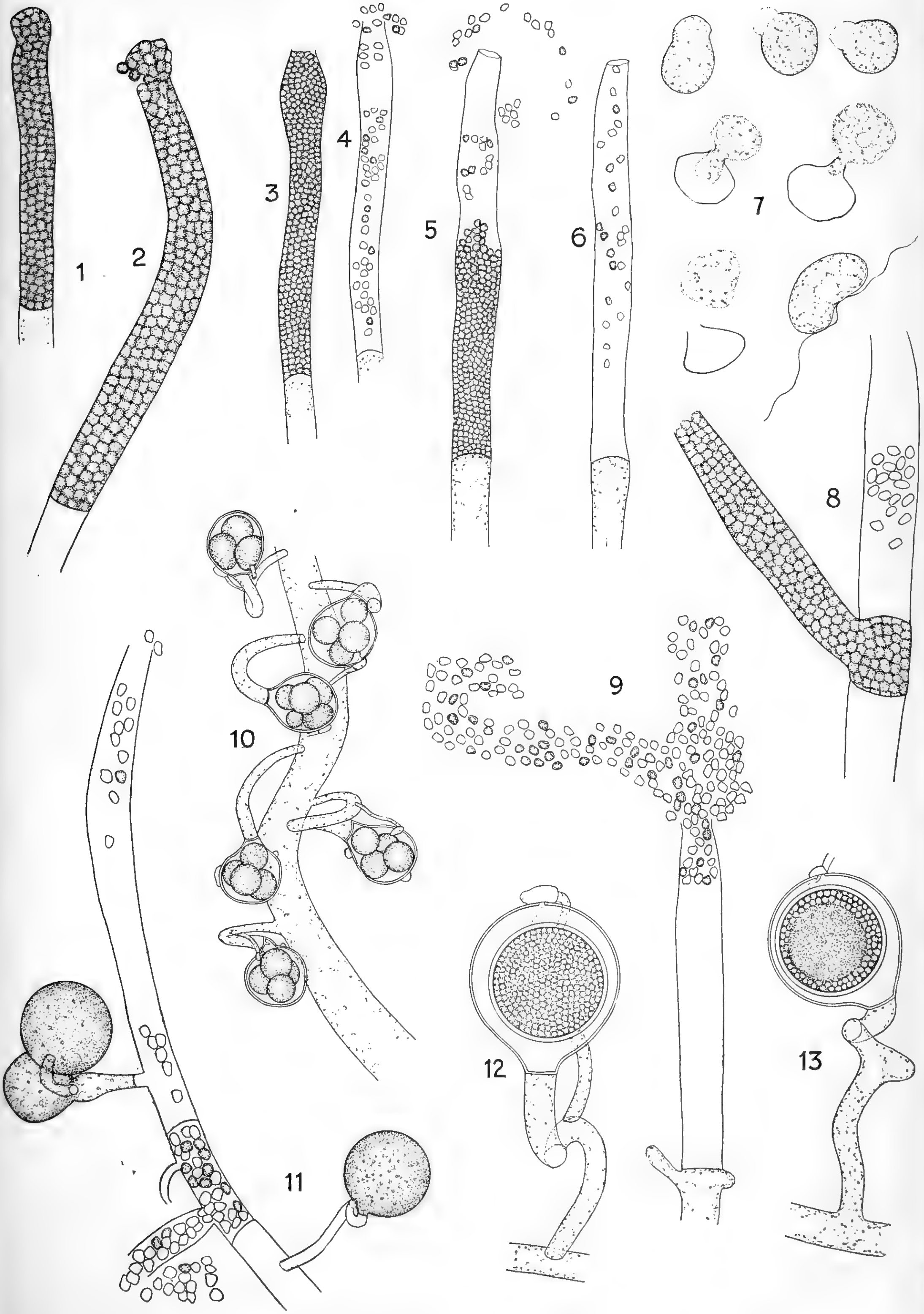
Fig. 2. Sporangium just after the apical swelling has cracked on one side.

Fig. 3. Sporangium after complete separation of the tip area with its included spores. A second swelling is shown that will lead to the expulsion of the next lower group of spores.

Fig. 5. Sporangium about half emptied.

Figs. 4, 6. Sporangia at the end of their activity, but shown, as always, with some loosely arranged spores still included. Most of these have left their cysts and escaped by swimming through the apex. Fig. 4 shows the same sporangium as fig. 3, and fig. 6 the same as fig. 5.

Fig. 7. Spores emerging from their angular cysts; one spore has taken its final shape and shows the cilia.



THRAUSTOTHECA ACHLYOIDES

Fig. 8. Two sporangia, one just after the complete separation of the tip.

Fig. 9. A nearly empty sporangium showing the arrangement of the spores after expulsion. Many have escaped from their cysts.

Fig. 10. A group of oogonia with antheridia, showing habit.

Fig. 11. Two sporangia and two oogonia, one of the former intercalary and with two mouths; one oogonium abnormal.

Fig. 12. Oogonium showing a mature egg, surface view, and an empty antheridium with tube.

Fig. 13. As in figure 12, but egg shown in optical section.

Figs. 3-6, 10 x 108; figs. 1, 2, 8, 9, 11 x 167; figs. 12, 13 x 247; fig. 7 x 720.

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